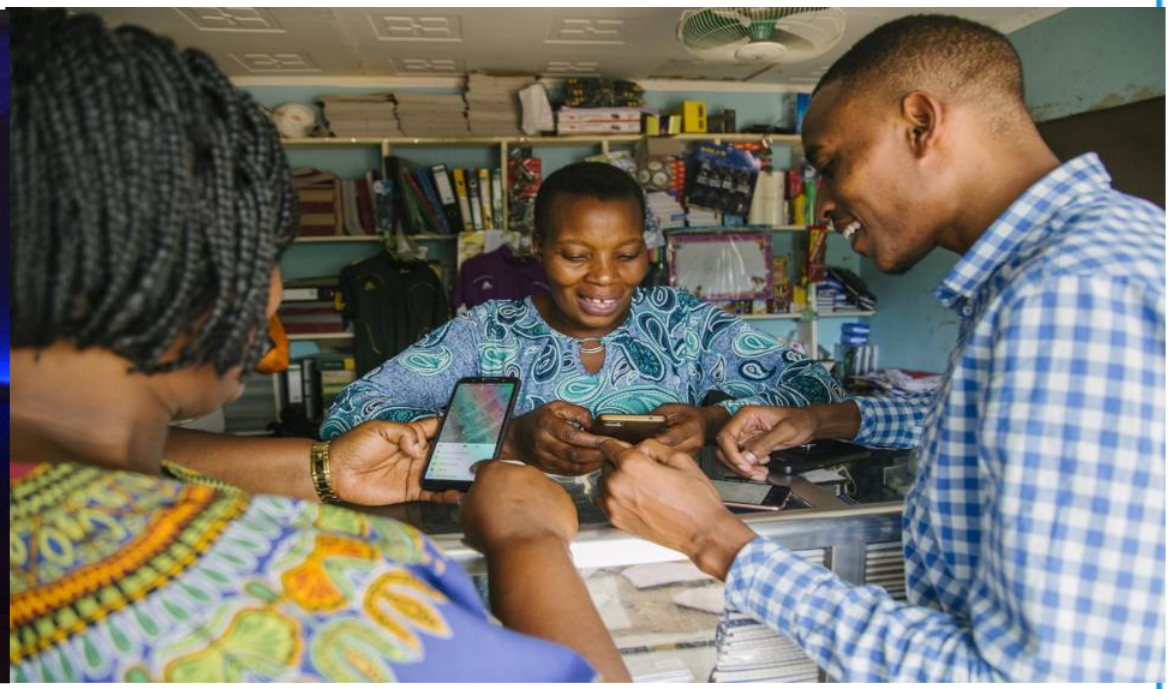
United Nations | Department of Economic and Social Affairs

UNDRR
UN Office for Disaster Risk Reduction



Risk-informed Governance and Innovative Technology for Disaster Risk Reduction and Resilience

Module 2.3: Connecting People, Things, and Information

Contents

1. Cloud Computing
2. 5G Mobile Technology and Wireless Mesh Networks
3. Mobile Messaging Systems
4. Internet of Things (IOT)
5. Distributed Ledger Technology (DLT or Blockchain)

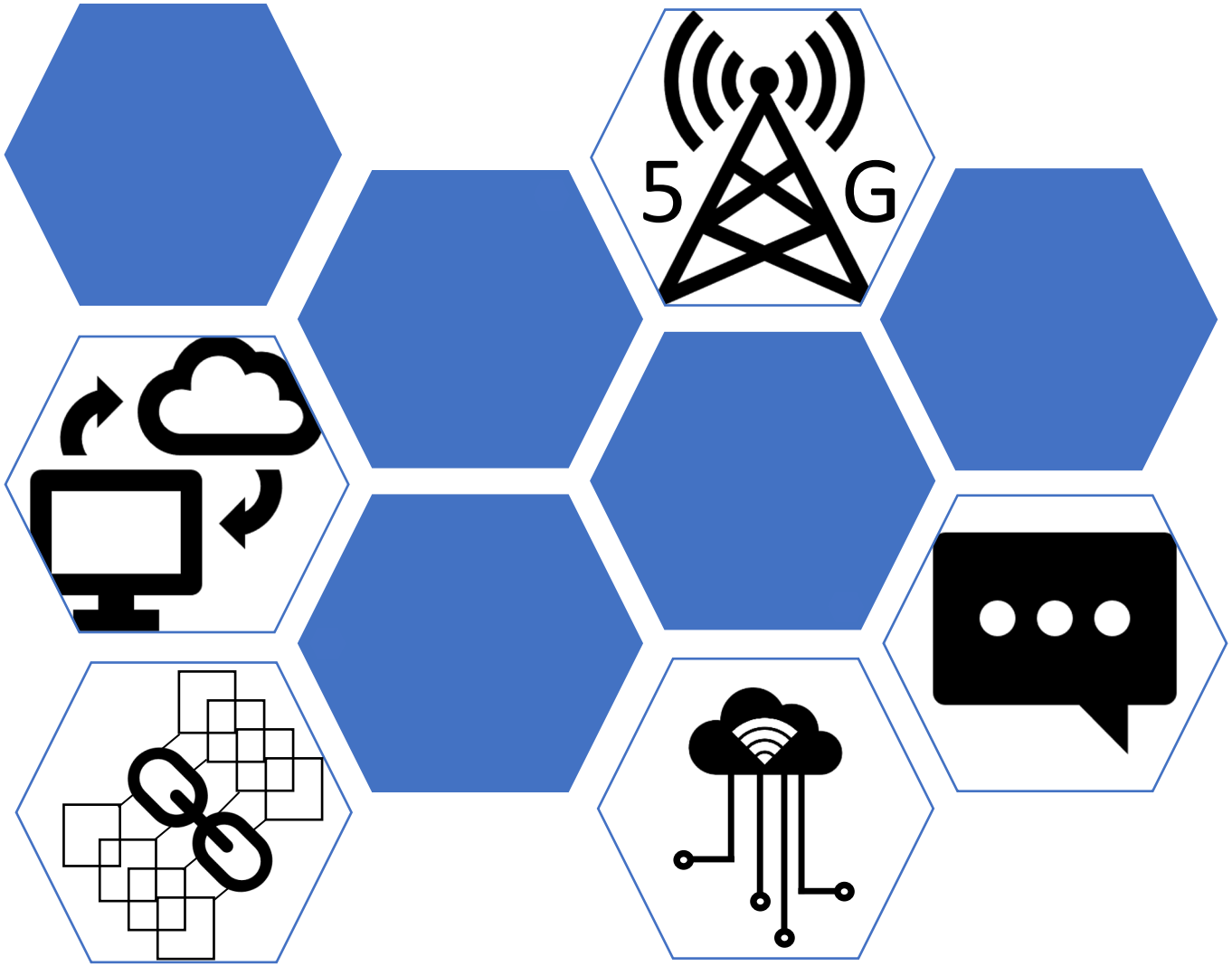
Learning Outcomes

At the conclusion of this Session, Participants will be able to:

- Assess the status of wireless and data communications infrastructure and identify capability gaps considering emerging technologies for DRR and resilience
- Identify and describe the DRR and resilience enhancement value of IoT systems, devices, and technologies that may be implemented on robust wireless and data communications systems
- Explain how distributed ledger technologies work and identify opportunities to enhance DRM through their application

Introduction

- Cloud Computing
- 5G Mobile Technology and Wireless Mesh Networks
- Mobile messaging
- Internet of Things (IOT)
- Distributed Ledger Technology (Blockchain)



Cloud Computing

Enhances:

- Data/information sharing and accessibility
  - Supports disaster risk management processes and functions
- Data/information security
  - Increases community resilience, even among stakeholders with no disaster risk management affiliation

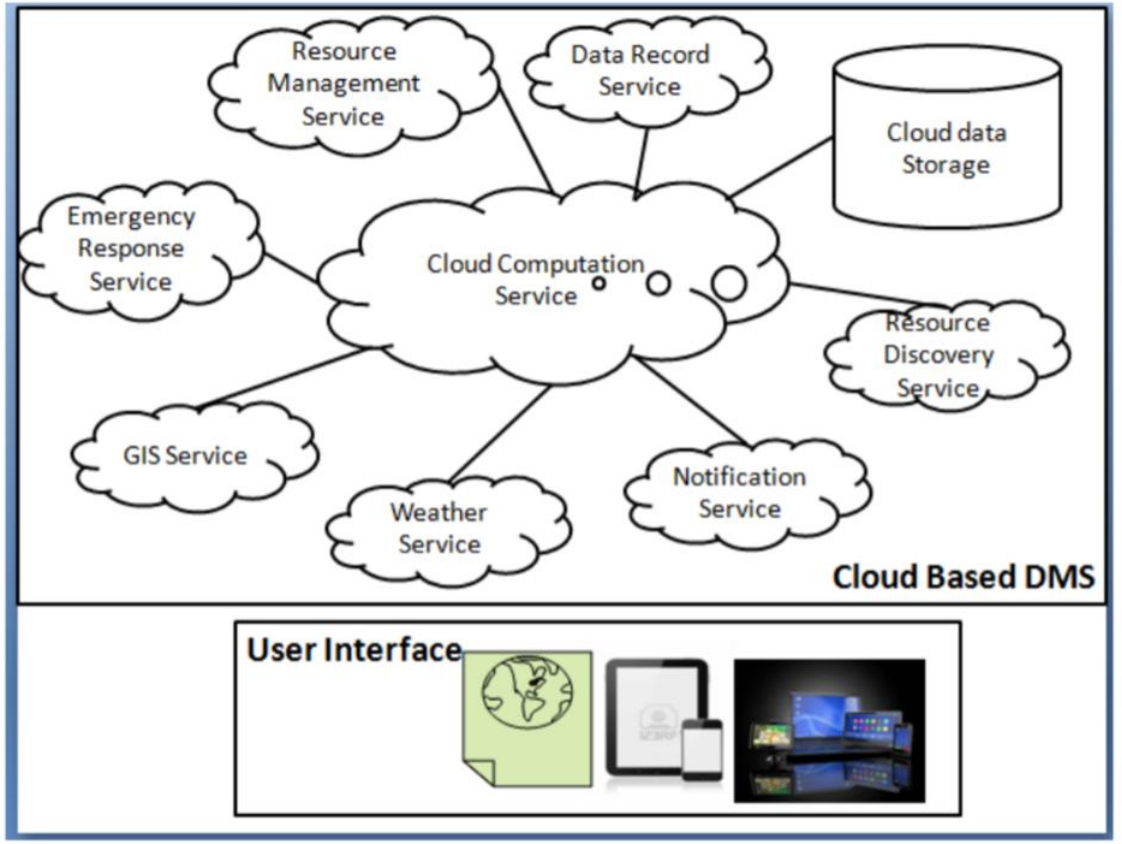


Image: Cloud-Based Disaster Management System.
Image credit: Habiba and Akhter (2013)

1. Cloud Computing

What is Cloud Computing?

- Internet-based
- More than just data/information storage
- Variety of approaches from data storage to processing
- Cloud computing ≠ e-Government

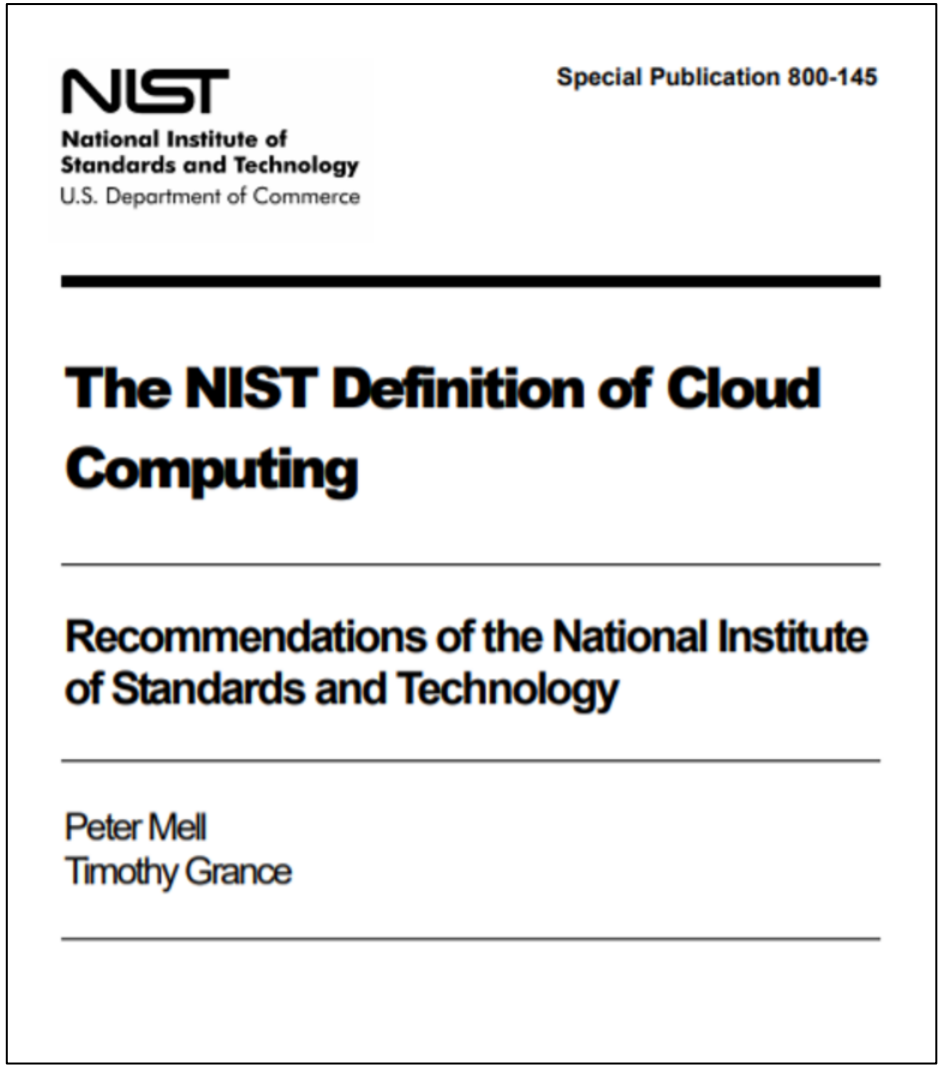
The delivery of computing services, including servers, storage, databases, networking, software, analytics, and intelligence, over the Internet ("the cloud") to offer faster innovation, flexible resources, and economies of scale."

Source: Microsoft, 2019.

1. Cloud Computing

Characteristics of Cloud Computing

- On-demand self-service
- Broad (ubiquitous) network access
- Resource pooling
- Rapid elasticity
- Measured service


NIST
National Institute of Standards and Technology
U.S. Department of Commerce

Special Publication 800-145

The NIST Definition of Cloud Computing

Recommendations of the National Institute of Standards and Technology

Peter Mell
Timothy Grance

Source: NIST, 2011.

Organizations Moving to the Cloud

1. Cost
2. Speed
3. Global scale
4. Productivity
5. Performance
6. Reliability

Source: Amazon Cloud Services, 2019.

Cloud Deployment Architectures and Services

Deployment Architectures

1. Public Cloud
2. Private Cloud
3. Hybrid Cloud

Types of Services

1. Infrastructure as a Service (IaaS)
2. Platform as a Service (PaaS)
3. Serverless Computing
4. Software as a Service (SaaS)

Image: IBM Magellan Cloud Computing Infrastructure
Image credit: Berkeley Lab, 2010.

- **Disaster Recovery as a Service (DRaaS)**

Benefits

1. Ease of Implementation
2. Access to Experts
3. Reduced Costs
4. Faster Data Recovery Speeds
5. Higher Levels of Security
6. Internet Accessibility
7. Peace of Mind

Source: Chris Potter, 2014.

Disadvantages of Cloud Services

1. Possible cost increases
2. Dependence on internet access
3. Risk of provider crash
4. Risk of provider physical damage
5. Data ownership questions
6. Security
7. Lack of user will or trust

Source: Blogtreprenuer, 2016.

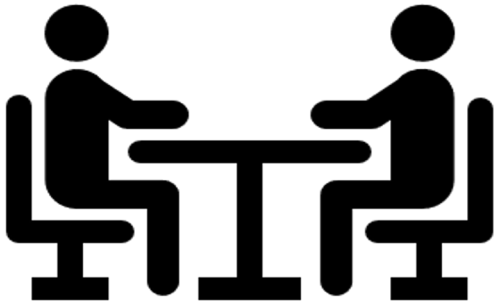
Enhancing Disaster Services with the Cloud

1. **Collaboration and planning**
2. **Rapid resumption of critical services**
3. **Rapid provision of emergency services**
4. **Capacity to manage surge in demand for data / information**
5. **Capacity to collect information**
6. **Virtual mission continuity**
7. **Reduced reliance on location**

Cloud computing is "*the best information technology for managing the complex and dynamic nature of disaster environments*".

- Habiba and Akhter, 2013

Group Work and Activities



Group Work and Activities

Discussion 1: The Computer in Your Pocket

- As communications technologies have continued to evolve, the prevalence and capacity of mobile phones are perhaps the most obvious examples of how ICT has changed our lives. These devices have put almost all the standard computing capabilities of traditional laptop and desktop computers within reach of people in all countries.
- With this powerful resource on our person at almost all times, our ability to utilize ICT for disaster risk management has expanded considerably.

  - **The Facilitator can** lead a discussion with participants about the different activities that they can do, or that they can do better or more efficiently, whether before, during, or after a disaster.
  - What is the specific technology that is contained in the mobile phone that gives people these capabilities?

Group Work and Activities

Discussion 2. How Can Cloud Computing Enhance Disaster Risk Management

- **The Facilitator** can divide the participants into groups of 4 or 5 participants per group.
- Each group should develop a list of four ways that cloud computing contributes to disaster risk management, providing one example for each disaster management phase (mitigation, preparedness, response, and recovery).
- Participants should explain if this capability is currently being applied in their country and relate any challenges that were encountered (or that are preventing the technology use altogether).

Case Study: US FEMA Cloud-Based Services

- **Problem**: High number of disaster-impacted people
- **Need**: System to allow people to apply for assistance quickly and from any location
- **Obstacle**: Server-hosted applications overwhelmed by high volume of applications
- **Solution**: Base applications and data in the cloud

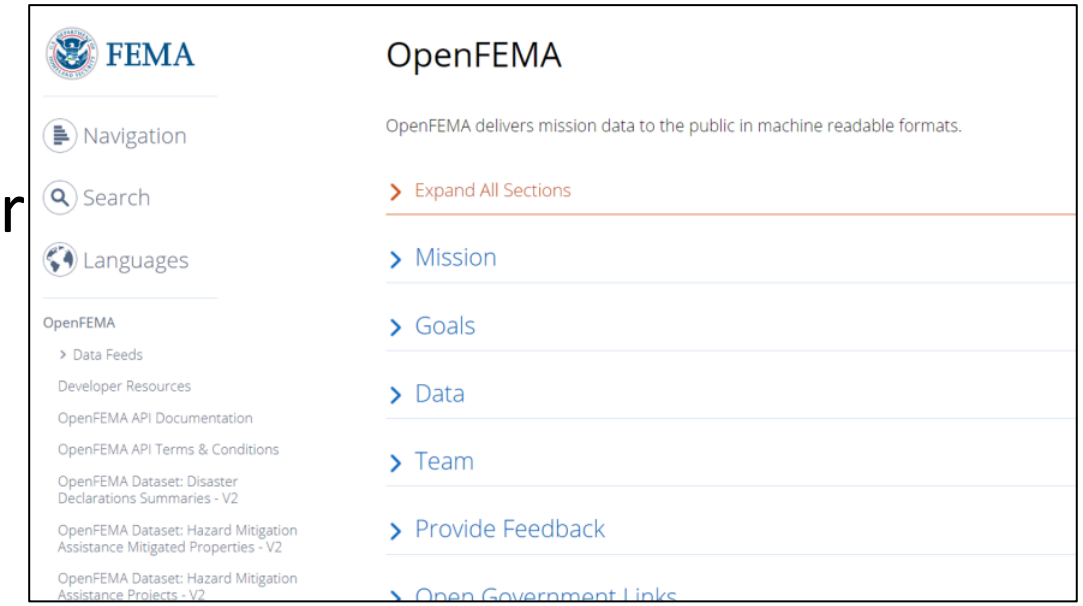


Image: OpenFEMA Website.
Source: FEMA, 2019.

Case Study: Japan Cloud Services in 2011

- **Problem**: Disasters cause profound interruptions in both the public and private sectors, causing a loss of services and economic impacts
- **Need**: Data assurance and rapid resumption of computing capabilities and access to services
- **Obstacle**: Servers and computing terminals damaged by disasters
- **Solution**: Mirroring of IT systems using cloud services

Image: The 2011 triple disaster in Japan devastated many industrial areas that were located in low-lying coastal zones.
Source: Yuichi Shiraishi, 2011.

2. 5G Mobile Technology and Wireless Mesh Networks

5G Mobile Technology

1. Collaboration and planning
2. Rapid resumption of critical services
3. Rapid provision of emergency services
4. Capacity to manage surge in demand for data / information
5. Capacity to collect information
6. Virtual mission continuity
7. Reduced reliance on location

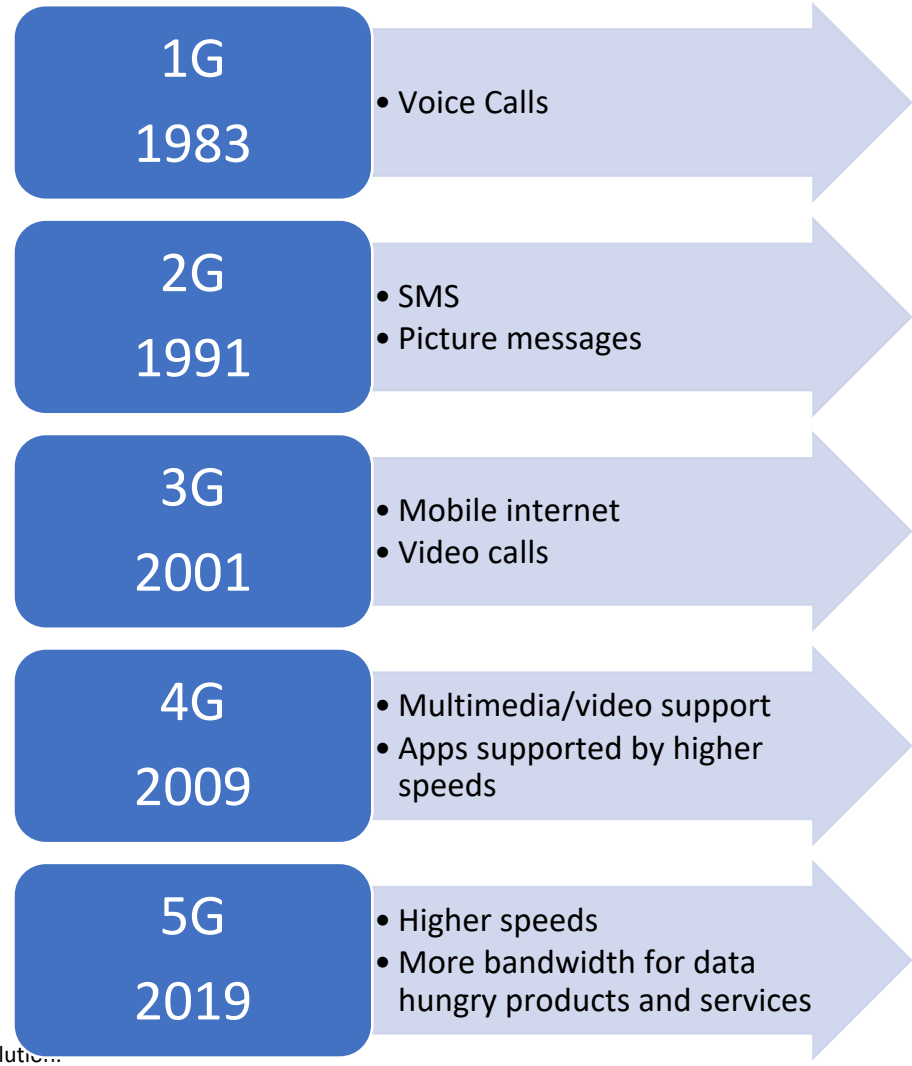


Image: Mobile technology evolution...
Source: Kelly Murphy, Samantha, 2019.

2. 5G Mobile Technology and Wireless Mesh Networks

- ## What is 5G?

Video: What is 5G?.
Source: CNBC, 2018.

2. 5G Mobile Technology and Wireless Mesh Networks

What Does 5G Do?

1. Mobile Phone Support
2. In-Home Internet
3. IoT Support
4. e-Government
5. Increased Virtual Collaboration

Image: 5G mobile advertisements in Birmingham, UK.
Source: JCDeceaux Creative Solutions, 2019.

2. 5G Mobile Technology and Wireless Mesh Networks

Case Study: Rush University Medical Center

- **Problem**: Traditional facility data networks require significant in-wall and exposed wiring
- **Need**: Reliable high-capacity data transmission capabilities with reduced installation and wiring requirements
- **Obstacle**: Cellular networking and internet solutions have not had enough capacity for data-intensive facilities like hospitals
- **Solution**: Facility-focused installation of a 5G network

Image: Rush University Medical Center, Chicago, USA.
Source: March Hinchman, 2017.

2. 5G Mobile Technology and Wireless Mesh Networks

Case Study: Upgrading Nationwide Emergency Network

- **Problem**: Response stakeholders from various sectors have significant communications and data sharing requirements during disasters.
- **Need**: Common communications and data sharing system.
- **Obstacle**: Although public safety communications networks exist, they are hindered by bandwidth limits.
- **Solution**: Upgrade existing public safety network to the new 5G network.

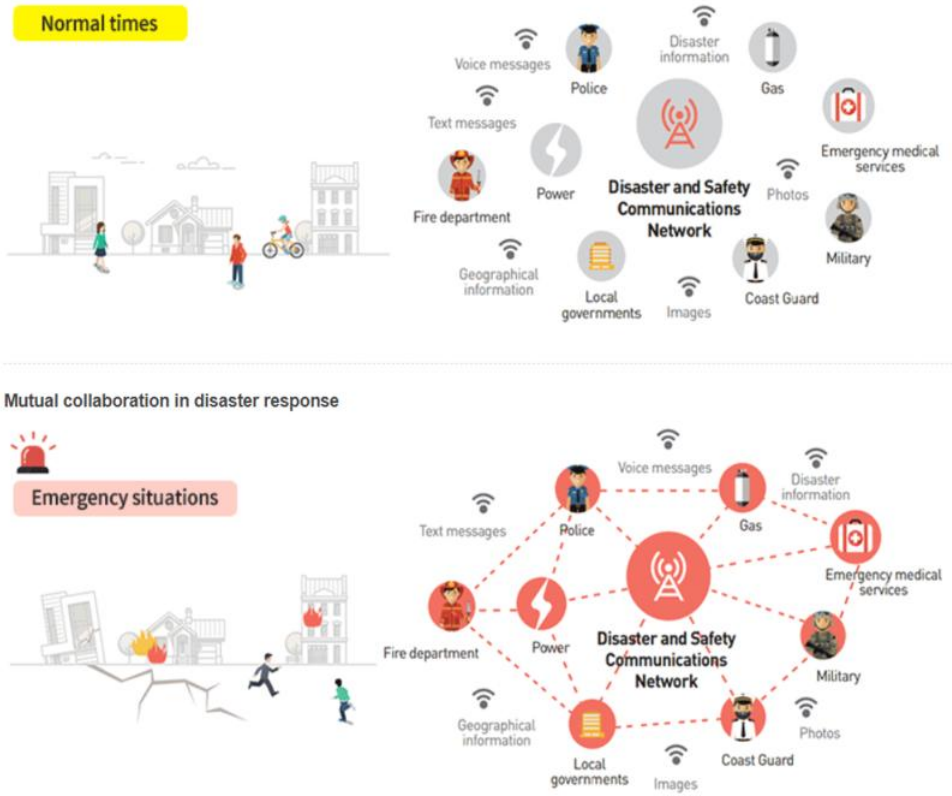
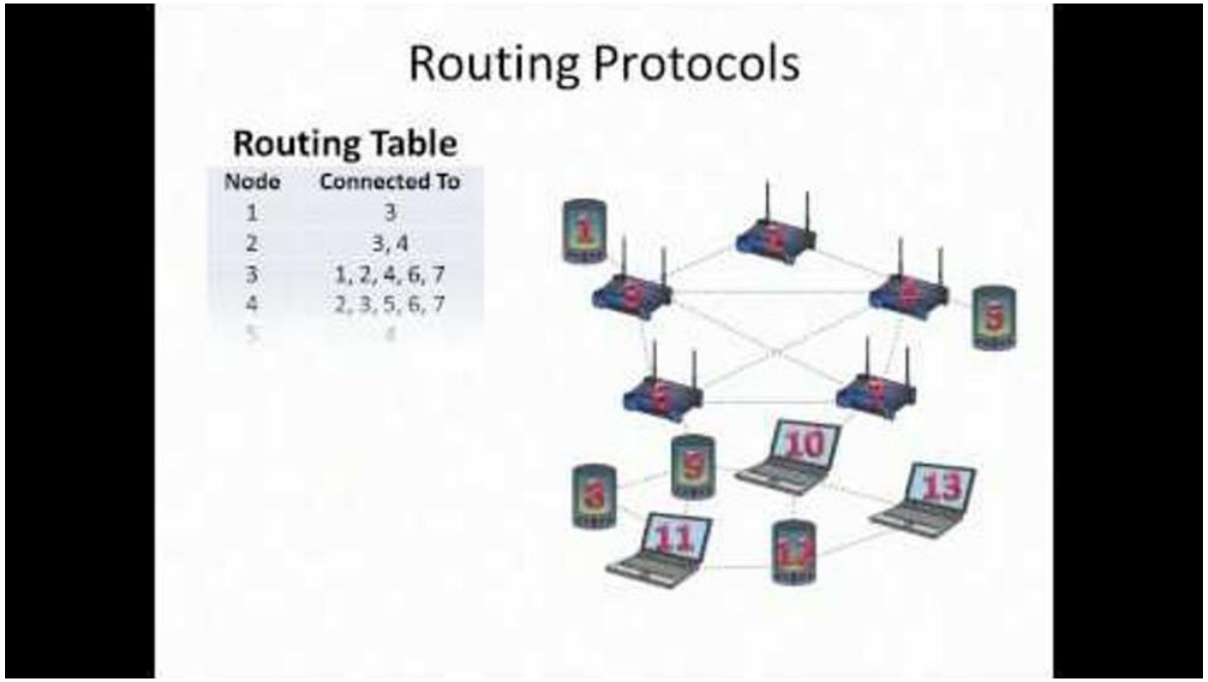


Image: Korea Safe-Net Architecture.
Source: Korea Ministry of the Interior and Safety, 2019.

2. 5G Mobile Technology and Wireless Mesh Networks

Wireless Mesh Networks

- Every device both a user and transceiver
- Each new device extends network reach
- Many limits of traditional networks are addressed



Video: How mesh networks work.
Source: Berkman Klein Center for Internet and Society, 2012.

2. 5G Mobile Technology and Wireless Mesh Networks

Case Study: Portable Network Kits (PNKs)

- **Problem**: Disasters often damage communications and internet infrastructure, just when communications needs are greatest.
- **Need**: Reliable communication between members of a community and each other as well as with external data sources.
- **Obstacle**: Infrastructure repairs can take days to weeks or more.
- **Solution**: Portable mesh network kits that allow for almost instantaneous communication following a disaster.

Image: Portable Network Kit (PNK).
Source: PNKgo.Com, 2019.

2. 5G Mobile Technology and Wireless Mesh Networks

Benefits of a Wireless Mesh Network

- Lower relative cost
- Increased capacity with use
- Adaptability
- Speed of setup
- Non-Line-of-Sight (NLoS) Capability
- Resilience
- Self-contained

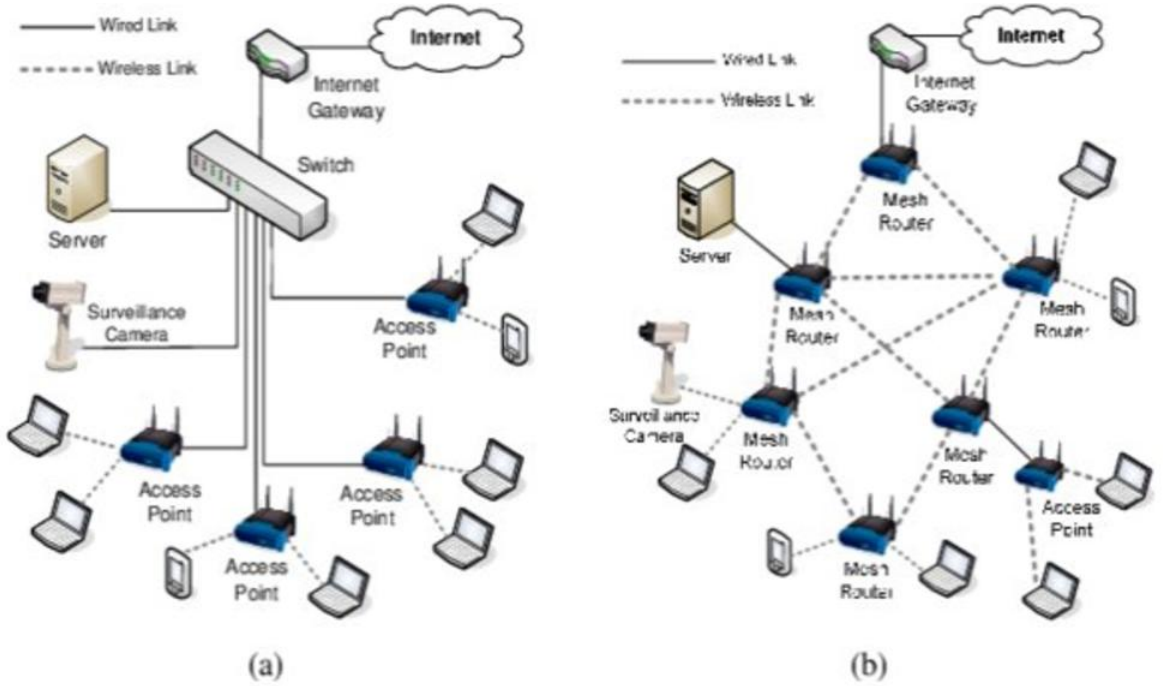


Image: Traditional versus Wireless Mesh Network.
Source: Portman, Marius, 2006.

2. 5G Mobile Technology and Wireless Mesh Networks

Applications of Mesh Networks

- Municipal wireless data coverage
- Expanding coverage in developing countries
- Access in isolated locations
- Access for one-time events or disaster situations

Image: Illustration of municipal wireless mesh network.

2. 5G Mobile Technology and Wireless Mesh Networks

Supporting DRM with 5G and Mesh Networks

- Collection of risk information
- Monitoring hazards
- Monitoring infrastructure

- Increased reliability
- Dedicated emergency networks
- Citizen science
- Locating impacted people
- Increased use of drones / robots
- IOT

- Training
- Education
- Community engagement

- Resumption of communication infrastructure
- Collaboration between recovery stakeholders
- Citizen participation in recovery planning

2. 5G Mobile Technology and Wireless Mesh Networks

Case Study: Commotion Wireless Mesh Networking Tool

- **Problem**: Community communication capabilities often depend on public or private sector infrastructure.
- **Need**: Organically-constructed communications infrastructure.
- **Obstacle**: Technical and hardware requirements of communications infrastructures exceed typical users' capabilities.
- **Solution**: Offer easy-to-use software solutions as an open-source tool so that anyone can turn their router into a mesh network node.

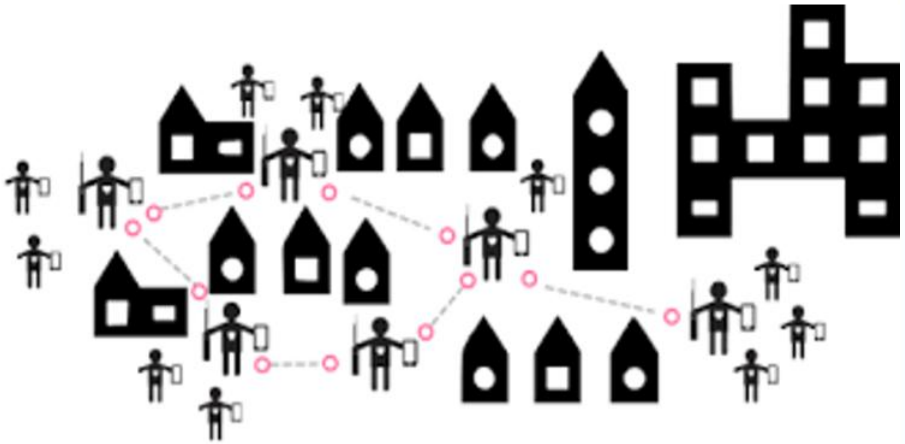


Image: Commotion Wireless infographic of organically-created mesh network.
Source: Commotion Wireless, 2019.

2. 5G Mobile Technology and Wireless Mesh Networks

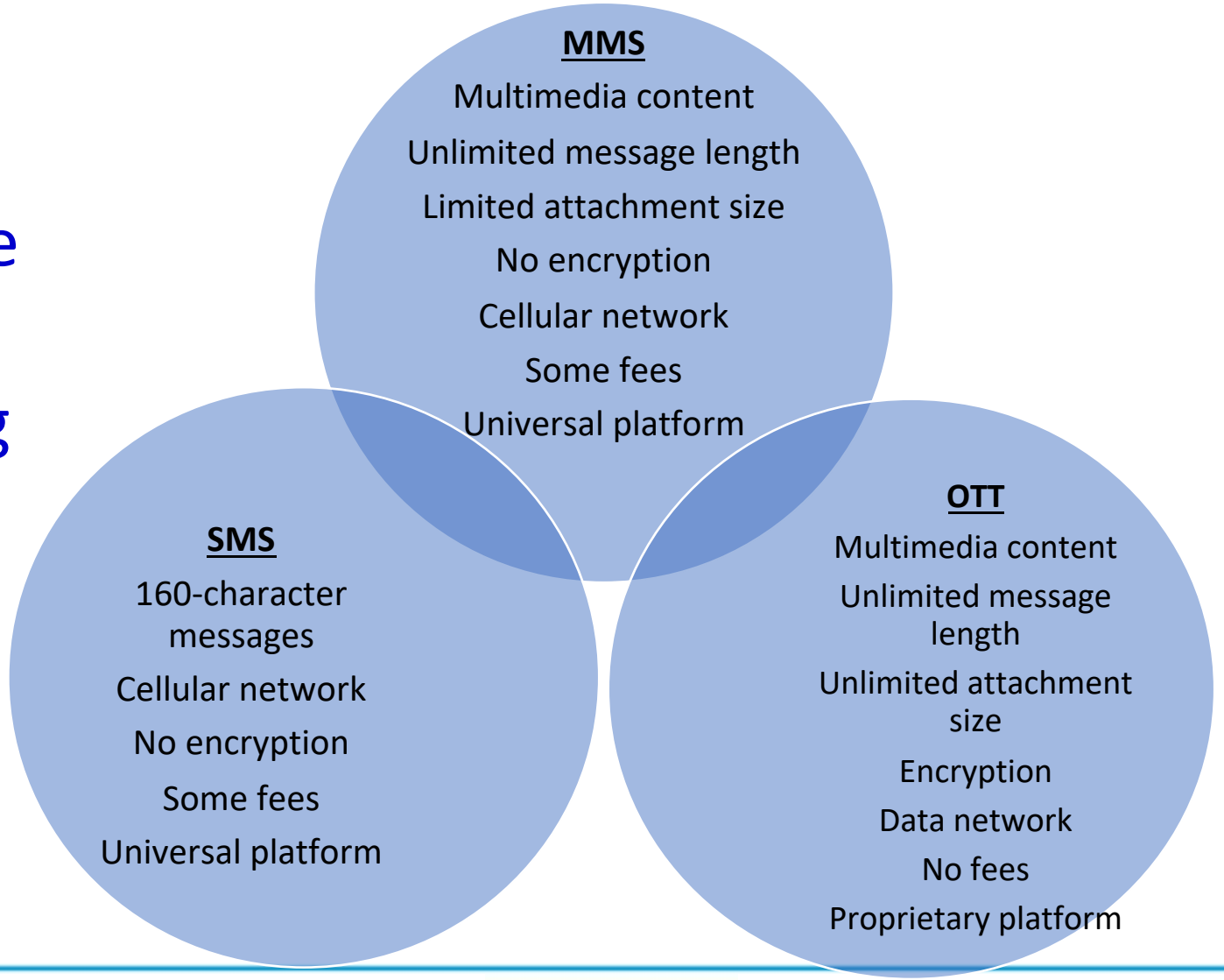
Case Study: Mesh Networking Following Dorian

- **Problem**: Disasters often damage communications and internet infrastructure, just when communications needs are greatest.
- **Need**: Responding organizations need reliable communications as soon as they commence operations.
- **Obstacle**: Infrastructure repairs can take days to weeks or more.
- **Solution**: Responding organizations develop the capacity to set up a mesh network as part of deployment preparedness.

Image: Damage to the business district in Marsh Harbour in Great Abaco Island in the Bahamas following Hurricane Dorian.
Source: Cheryl Diaz Meyer, NPR, 2019.

3. Mobile Messaging Systems

- Short Message Service **(SMS),**
- Multimedia Messaging Service **(MMS), and**
- Over-the-Top **(OTT)**



3. Mobile Messaging Systems

SMS vs. OTT vs. RCS

Rich Communication Services (RCS)

- Combines the best of SMS/MMS and OTT, including:
- Integrates with contact apps to find users
- Group chats
- Video and audio messages
- Hi-resolution images up to 10 MB in size
- Share location
- Receive read receipts
- See when people are replying in real time

	SMS	OTT	RCS
USAGE	SMS is supported by every mobile network and device in use today. As such, any user on any platform or device can text other users on other platforms and devices.	OTT applications are closed ponds of users and don't allow users to share in other apps. For example, a WeChat user cannot send a message into Facebook Messenger.	Being rolled out by a number of carriers globally.
DEFINING FEATURES	SMS messages are limited to 160 characters per message. Messages longer than that are numbered and linked together. File sharing also differs and in general cap at 300 KB per file.	OTT apps are generally better for file sharing since they don't have the size limitations of SMS messages. They also have more features: group messaging, message sharing, and audio/video calling.	Improved integration of more traditional OTT app features, now universally applied without needing to download an app to access.
SECURITY	Not encrypted.	Encrypted	Not encrypted.
CONNECTION	Uses cellular networks	Uses Internet protocols	Uses data networks.
COST	Carrier Dependent	Free	Carrier dependent
GLOBAL USAGE	Data rate plans in non-US countries reduce SMS usage	Given the ubiquity of internet connection globally, apps that replace SMS have seen rapid expansion.	55 national operations have launched Rich communication systems. All four major US carriers support the standard. Vodafone, Deutsche Telekom, Claro, KT, LG Uplus and SK Telecom cover most of the rest of the world.

Image: Kristina Libby, 2019.

3. Mobile Messaging Systems

DRM Applications for Mobile Messaging

- Alert and Warning
- Citizen Science
- Status Checks
- Search and Rescue and Relief Alerting

Image: Mobile phone screenshot of a mistaken warning message, January 2017.

3. Mobile Messaging Systems

Case Study: Mission 4636

- **Problem**: Disaster victims throughout the impacted area will face a variety of rescue needs.
- **Need:** A method to communicate needs to responders.
- **Obstacle**: Multiple languages are spoken by citizens, and many locations do not have official numerical addresses.
- **Solution**: SMS-based reporting line staffed with volunteer translators and staff capable of georeferencing messages.

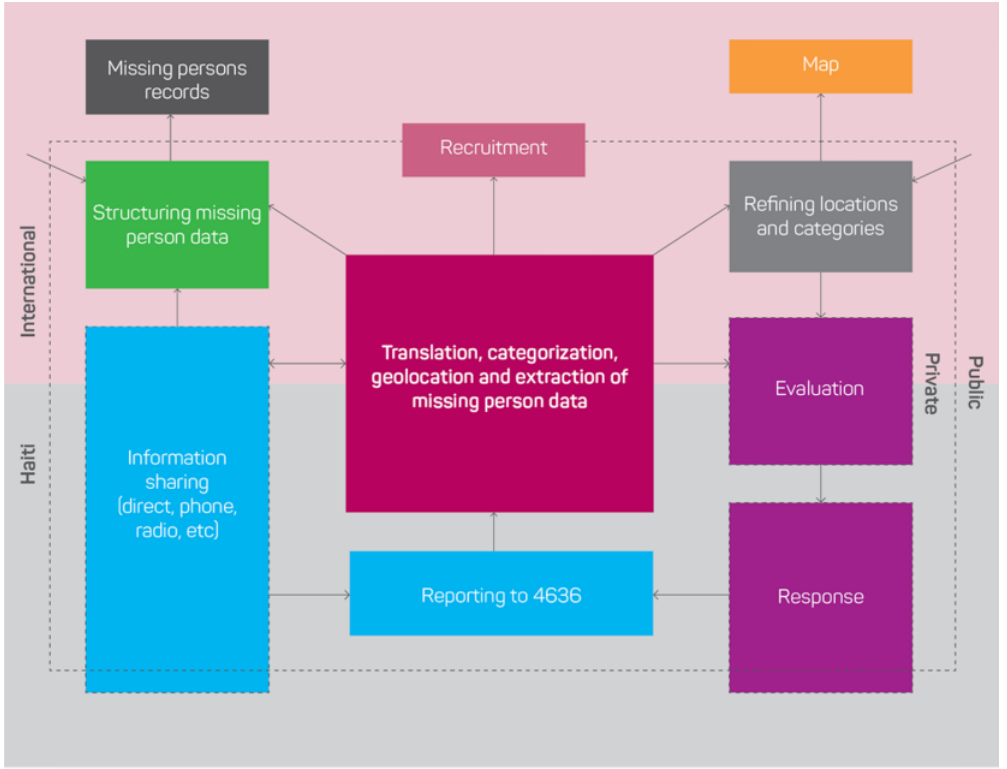


Image: 4636 Process.
Source: Chhetri, Prem, 2017. http://bit.ly/36DEpVc.

3. Mobile Messaging Systems

Case Study: Wireless Emergency Alert System

- **Problem**: Multiple alerting systems may cause confusion or lead to redundant development efforts and differing standards.
- **Need:** Single national mobile alerting system.
- **Obstacle**: Organizational cooperation and bureaucratic challenges.
- **Solution**: Legally-mandated national alerting system that all mobile providers and all national alerting agencies must participate in.

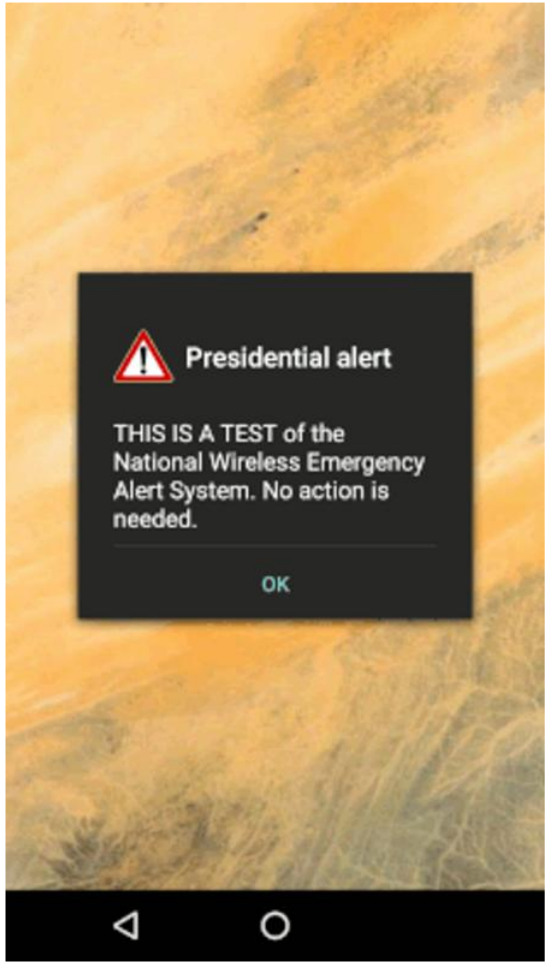


Image: WEA test message.
Source: WFP, 2019.

3. Mobile Messaging Systems

Case Study: WFP Mobile Vulnerability Analysis and Mapping (mVAM)

- **Problem**: DRM stakeholders must manage the life sustaining needs of disaster impacted populations.
- **Need**: Frequent and reliable data on food security.
- **Obstacle**: Collection of this data is time and resource intenstive.
- **Solution**: Mobile surveys and reporting mechanisms that allow thousands to report conditions and needs.

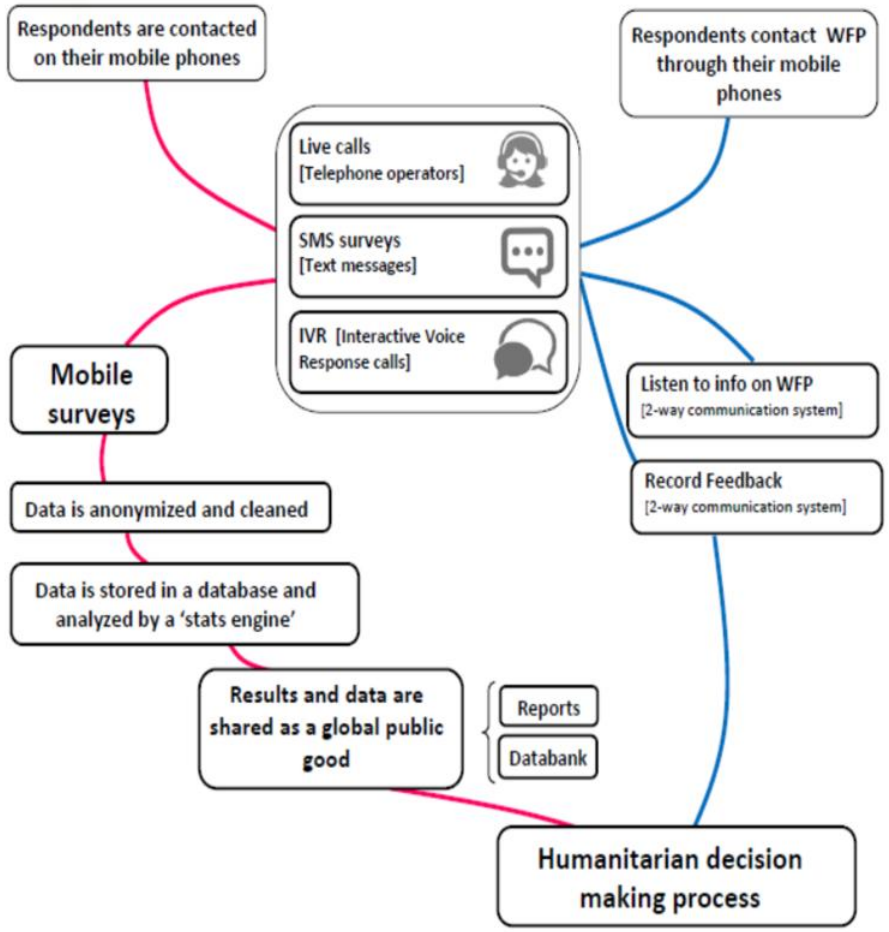


Image: mVAM information flow.
Source: WFP, 2019.

3. Mobile Messaging Systems

Case Study: Trilogy Emergency Response Application (TERA)

- **Problem**: Communication between humanitarian organizations and recipients can be difficult to establish and maintain.
- **Need**: Reliable and cost-effective 2-way communication system.
- **Obstacle**: There are few common communication channels among a diverse group of impacted people.
- **Solution**: SMS-based communication system that allows for targeted or general alerting, and 2-way communication.

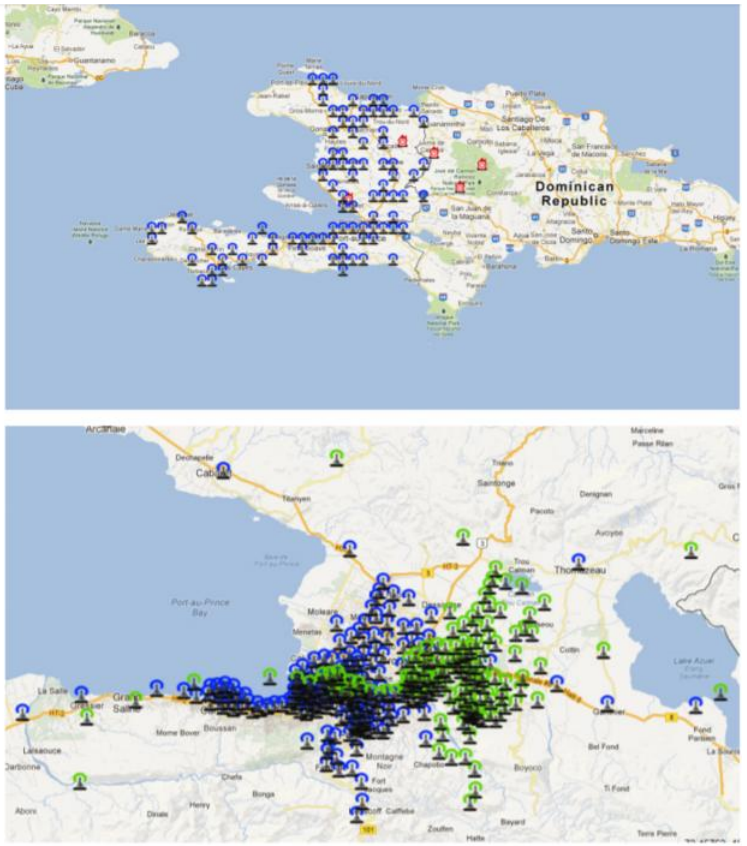


Image: Screenshot of TERA alerts.
Source: IFRC, n/d.

4. Internet of Things (IoT)

Internet of Things (IoT)

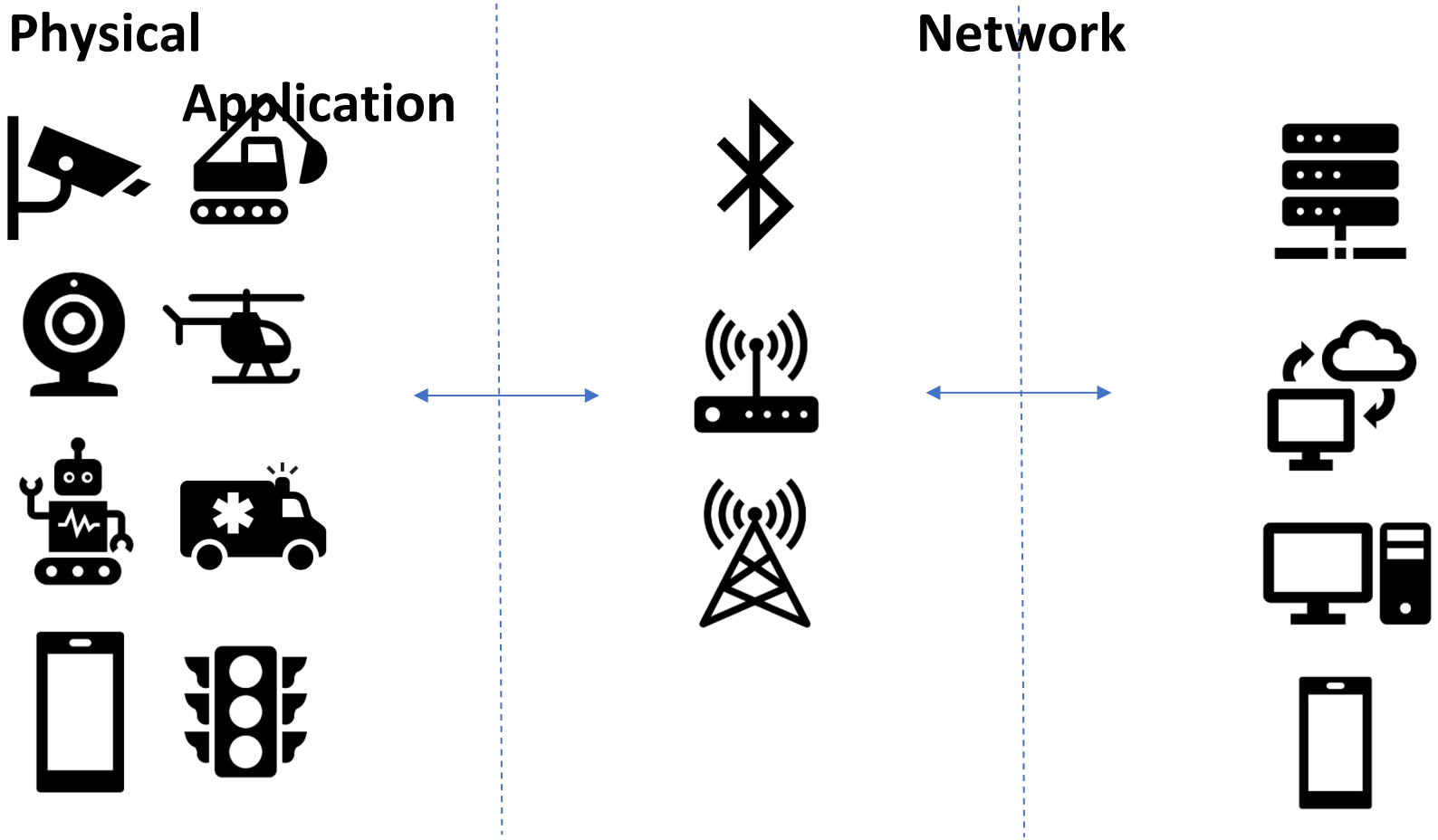
- A technological domain
- Not a 'technology' in and of itself
- Presents capabilities – enabler of frontier and other technologies
- Two primary purposes of the 'things':
  - Sensing
  - Actuation

IoT = A network that connects uniquely identifiable things to the internet.

Source: Minerva, Biru, and Rotondi, 2015.

4. Internet of Things (IoT)

- **IoT System Architecture**



4. Internet of Things (IoT)

IoT for DRM and Resilience

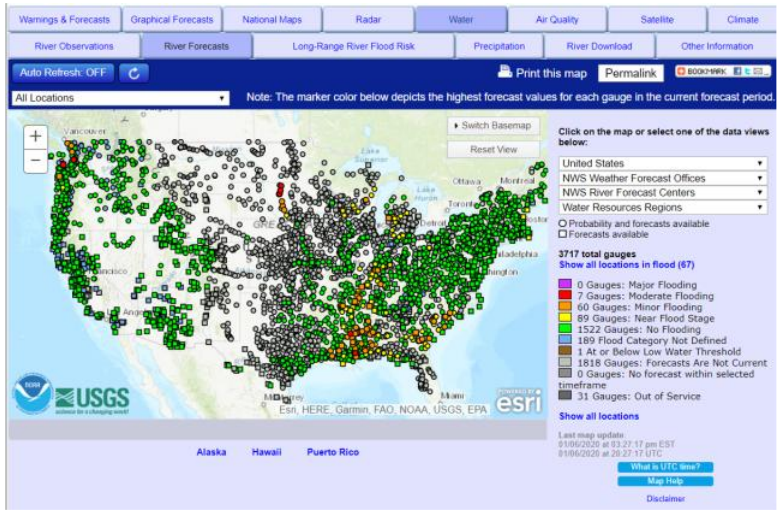


Image: Map of active government-affiliated flood gauges in the United States. Source: US Geological Survey, 2020.

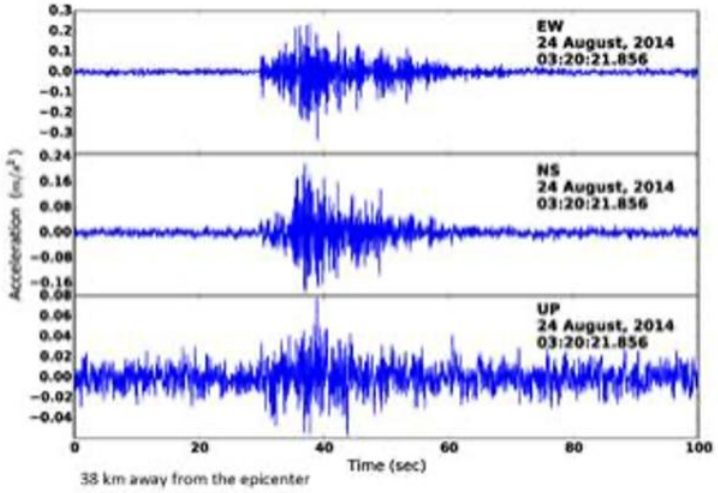


Image: Motion sensors in a smartphone recorded ground shaking during the 2014 Napa earthquake. The phone detected motion in three dimensions — east/west, north/south and up/down..

Mitigation and Preparedness

- Sensing (measuring) hazard drivers/indicators/data
- Citizen science
- Training and education

Response and Recovery

- Remote operation of vehicles & devices
- Communication
- Collaboration
- Situational readiness
- Big data analytics

4. Internet of Things (IoT)

Case Study: IoT for River Flooding in Colombia

- **Problem**: Risk from rivering flooding and associated landslide risk threaten citizens in a remote village community.
- **Need**: Early warning capabilities.
- **Obstacle**: Manual collection of rivering and precipitation data is not responsive enough to provide effective warnings.
- **Solution**: IoT-connected sensors and an automated warning system identify flood risk and communicate that to DRM stakeholders.

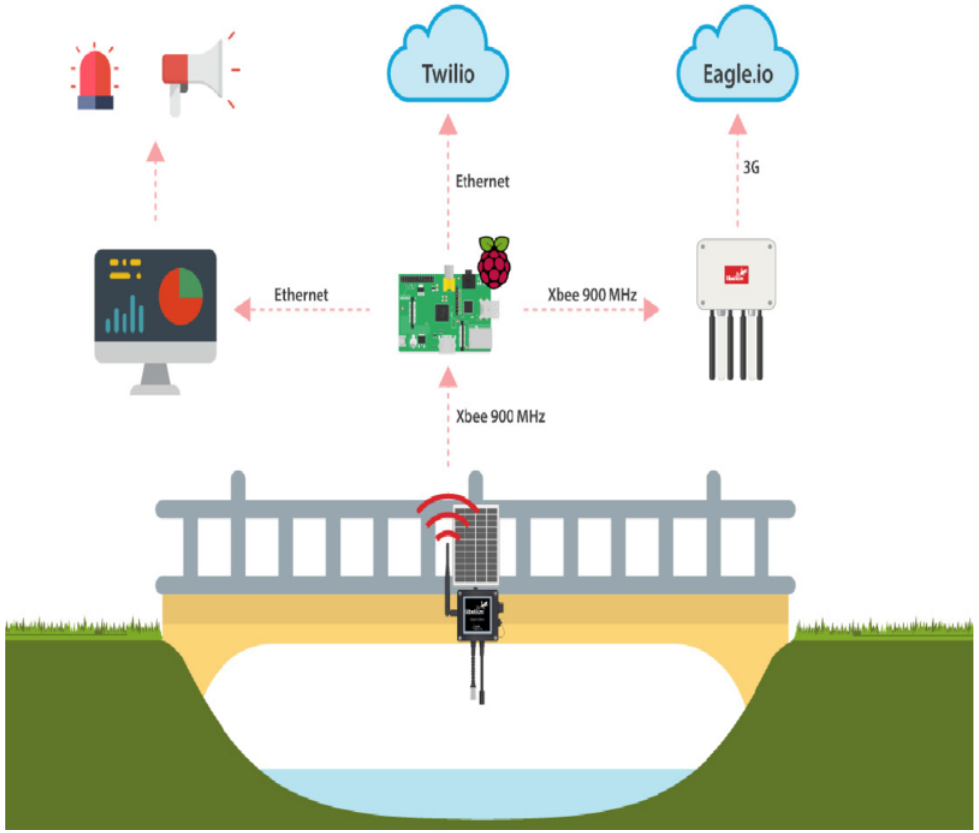


Image: Salgar early warning system diagram.
Source: ITU, 2019.

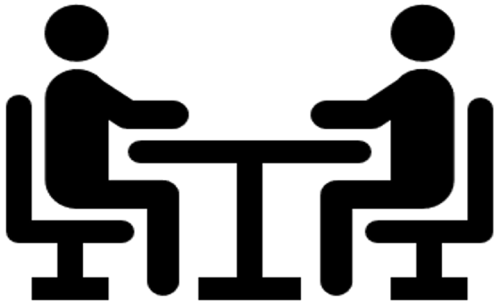
4. Internet of Things (IoT)

Case Study: Floating River Water Quality Sensors

- **Problem**: Riverine contaminants and other hazards can quickly and profoundly impact drinking water resources.
- **Need**: Data on river flow and content.
- **Obstacle**: Stationary, wired sensors are not able to provide information across the length of a river.
- **Solution**: IoT-connected floating sensors provide data along the length of a moving waterway.

Video: California Floating Sensor System.
Video Length: 2:19.

Group Work and Activities



Group Work and Activities

Discussion 3: IoT-based Training Needs

- As a distinct domain, IoT requires a significant amount of training for different sectors and people.
- No specific agency or office oversees IoT, because it is not a thing that is installed or maintained. Rather, like the internet, it is just there. Its utility is almost universal, and many staff will need to understand how it works and how it impacts their own job functions.
- **The facilitator** can lead a discussion on the different aspects of training that will need to be addressed to ensure that IoT is effectively harnessed for DRM and community resilience.
    - Who needs to be trained?
    - What are the different topics of training?
    - What are the training and education priorities?
    - Who is best positioned to conduct training and education for IoT?

5. Distributed Ledger Technology (DLT or Blockchain)

Distributed Ledger Technology

- Related to cloud computing
- *Digital applications that enable and ride on top of distributed ledgers.*
  - Digital application: program that performs some task or function
  - Digital ledger: a database
  - Distributed ledger: database stored in a decentralized manner (shared)

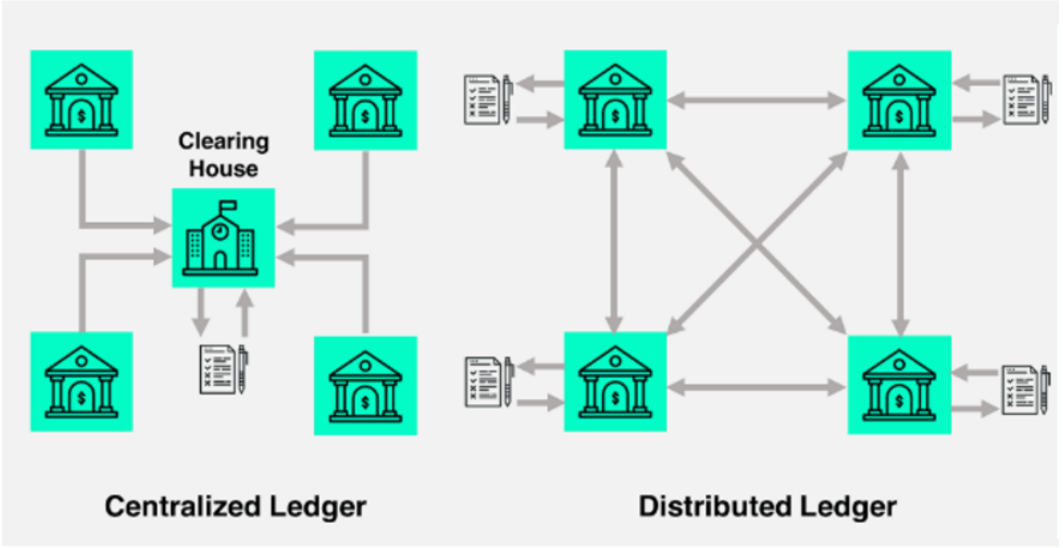


Image Source: Belin, Oliver. 2019. TradeIX. http://bit.ly/2t1FFTy

5. Distributed Ledger Technology (DLT or Blockchain)

- **Distributed Ledger Value and Component Parts**

Value

- Transparency
- Auditability
- Resiliency
- Streamlining

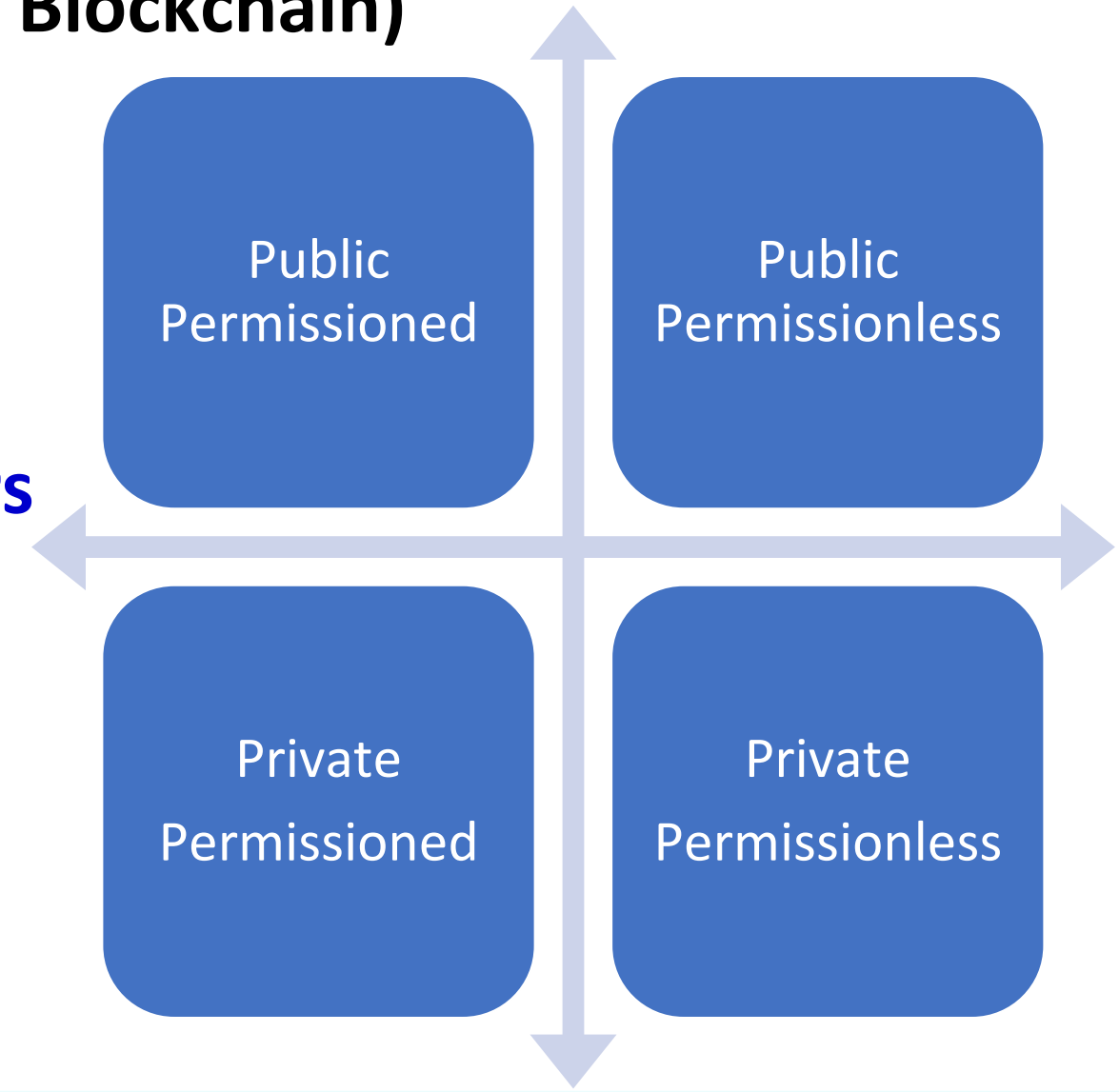
Component Parts

1. Applications
2. Protocol and Network
3. Infrastructure

Image Source: Belin, Oliver. 2019. TradeIX. http://bit.ly/2t1FFTy

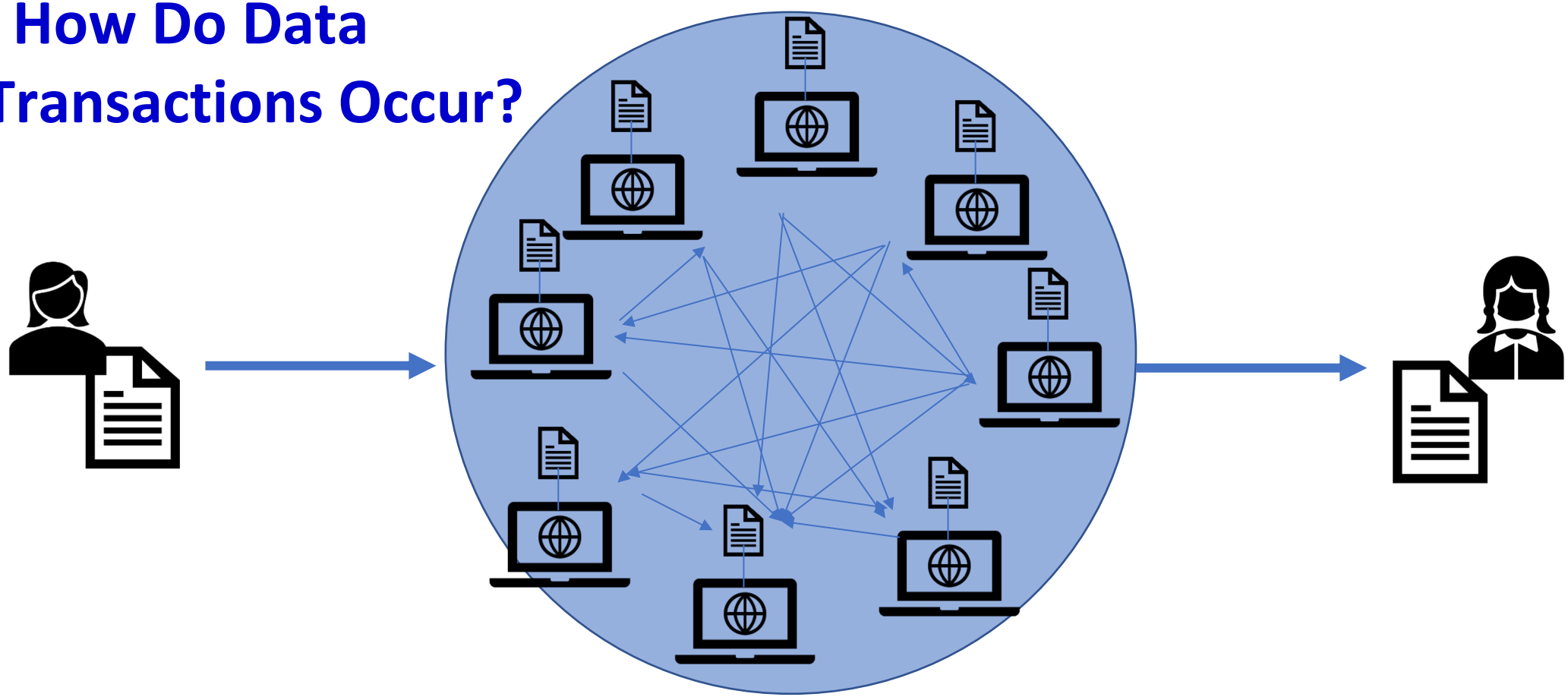
5. Distributed Ledger Technology (DLT or Blockchain)

- **Types of Distributed Ledgers**



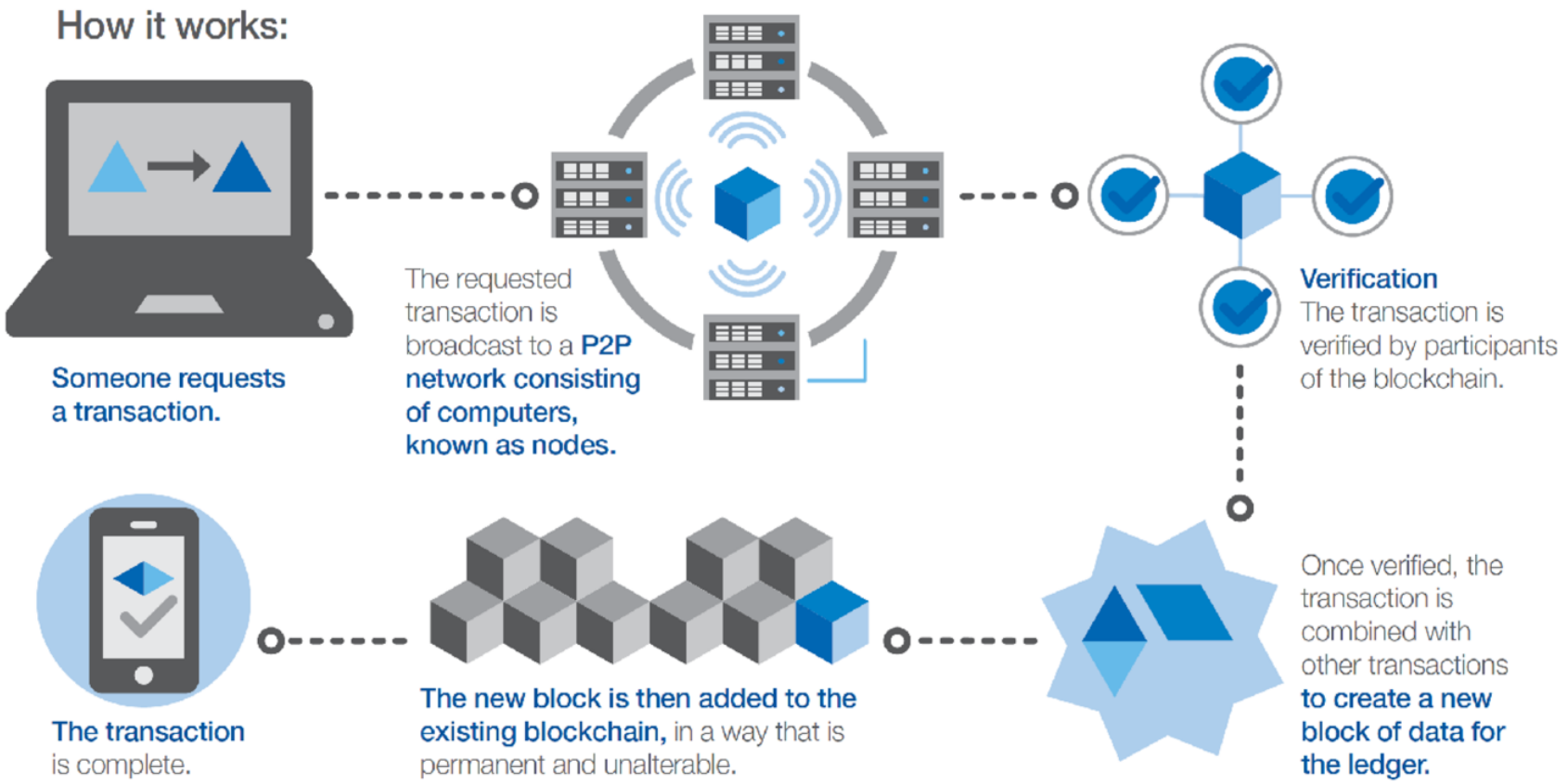
5. Distributed Ledger Technology (DLT or Blockchain)

- **How Do Data Transactions Occur?**



5. Distributed Ledger Technology (DLT or Blockchain)

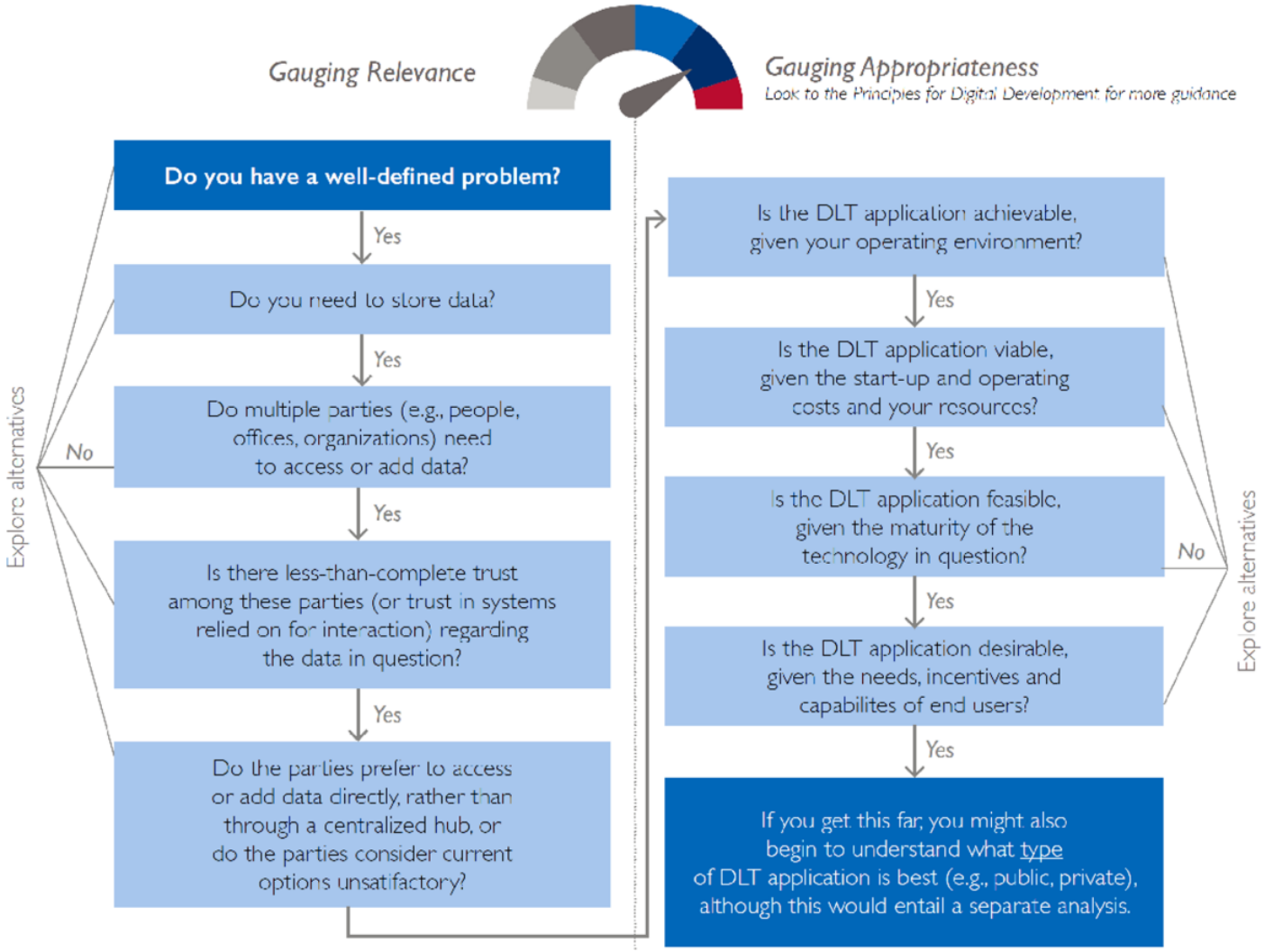
- **Blockchain**



Source: WEF, 2018.

5. Distributed Ledger Technology (DLT or Blockchain)

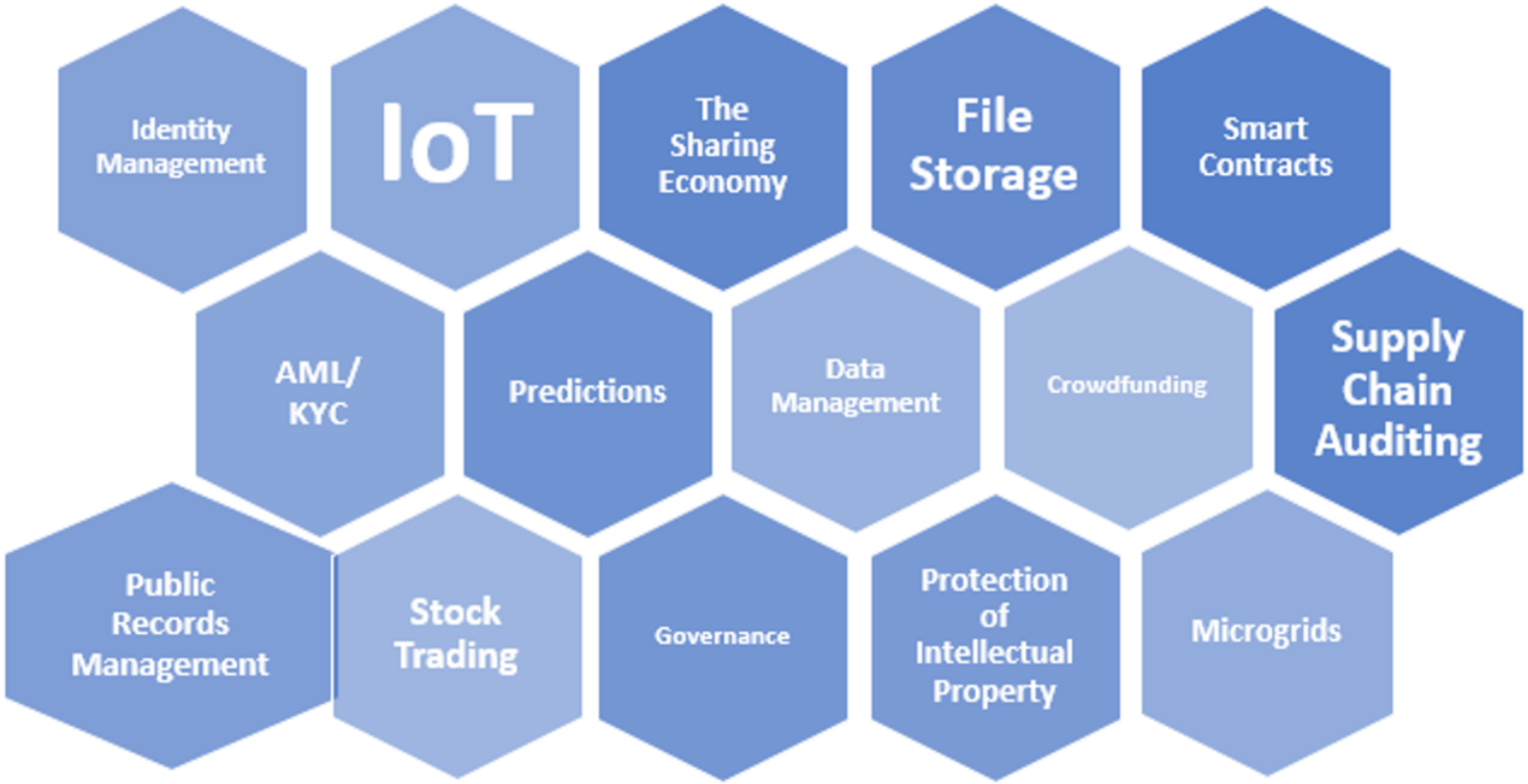
- **When are Distributed Ledgers Useful?**



Source: USAID, https://app.box.com/s/ii79pbiy07hrqvugs30r83lpwqkxhe62

5. Distributed Ledger Technology (DLT or Blockchain)

- **Distributed Ledger Technology DLT Uses**



Source: USAID, n/d https://app.box.com/s/ii79pbiy07hrqvugs30r83lpwqkxhe62.

5. Distributed Ledger Technology (DLT or Blockchain)

Benefits and Challenges of Distributed Ledger Technology DLT

Benefits

- Decentralized capacity to conduct data transactions
- Reduced transaction costs
- Increased transparency
- Immutability, reliability, and historical verifiability
- Increased access
- Ability to monitor, audit, and ensure compliance

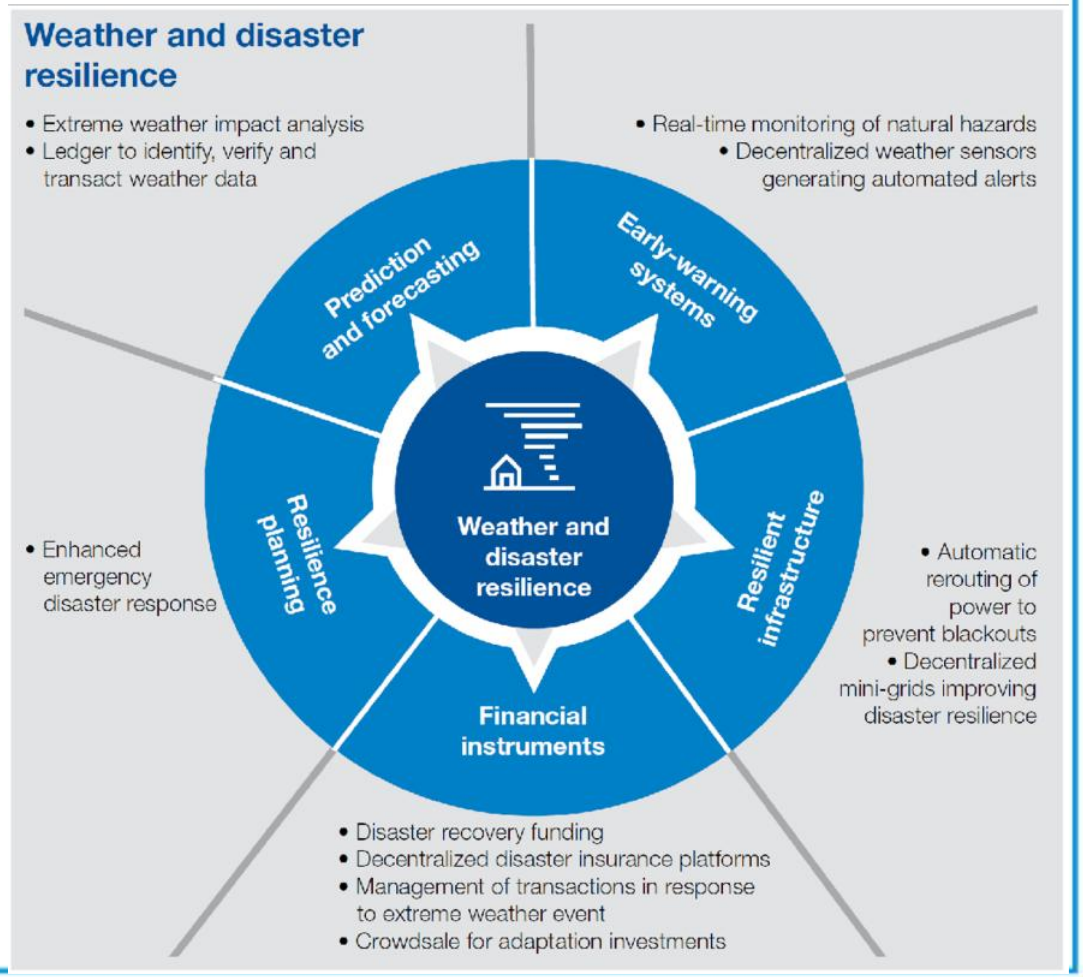
Challenges

- Resistance to adopt or use
- Inability to use
- Fraudulent use of a DLT
- Legal or regulatory challenges
- Interoperability challenges
- Energy consumption

5. Distributed Ledger Technology (DLT or Blockchain)

Distributed Ledger Technology DLT for DRM and Resilience

- Collection and Management of Disaster Financing
- Disaster Preparedness
- Standards of Care
- Emergency Shelter and Nutrition
- Emergency Medical and Public Health Services
- Vital Personal Documents



Source: WEF, 2018.

5. Distributed Ledger Technology (DLT or Blockchain)

Case Study: Humanitarian Cash Transfers in Vanuatu

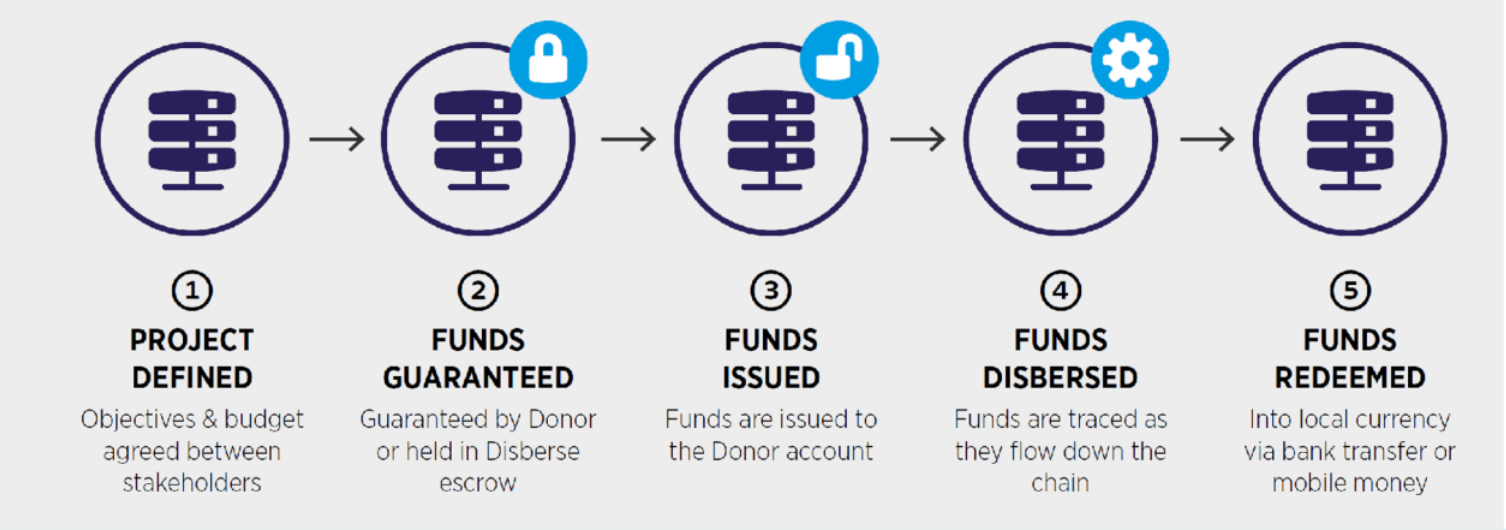
- **Problem**: Disaster impacted populations experience cash shortages for a variety of reasons.
- **Need**: Access to cash or a viable cash alternative.
- **Obstacle**: Banks may not be operating; cash programs are often associated with poor transparency / accountability.
- **Solution**: Blockchain-based cash card program in partnership with verified businesses in the impacted area.

Image: Sempo employees train Oxfam Vanuatu project team members to use the blockchain-based cash transfer technology..
Source: Sempo, 2019.

5. Distributed Ledger Technology (DLT or Blockchain)

Case Study: Disberse Humanitarian Aid Delivery Platform

- **Problem**: Project funds need to be transferred from donor to recipient.
- **Need**: Security and accountability of funds.
- **Obstacle**: Traditional systems often have no means of enabling tracing of funds or reporting on their disbursement and use.
- **Solution**: Cryptocurrency (blockchain)-based development financing infrastructure.



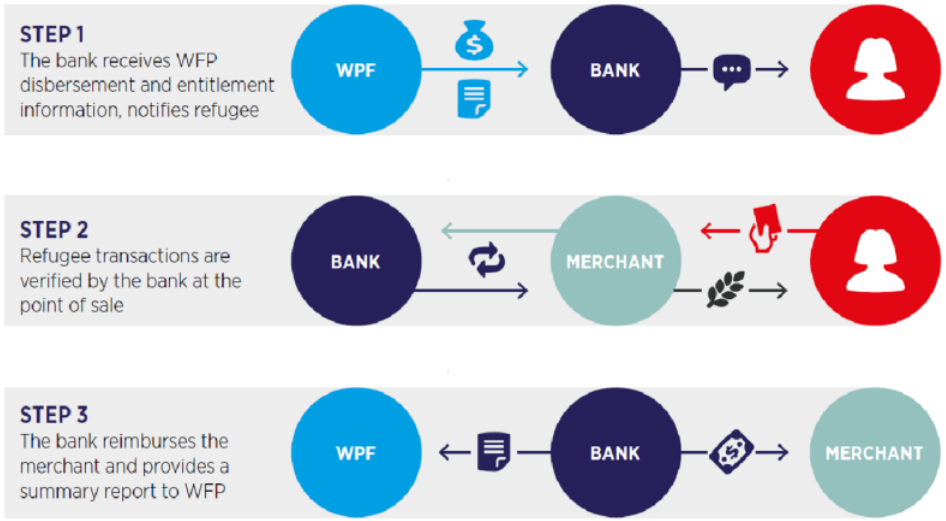
Source: Disberse: 2019.

5. Distributed Ledger Technology (DLT or Blockchain)

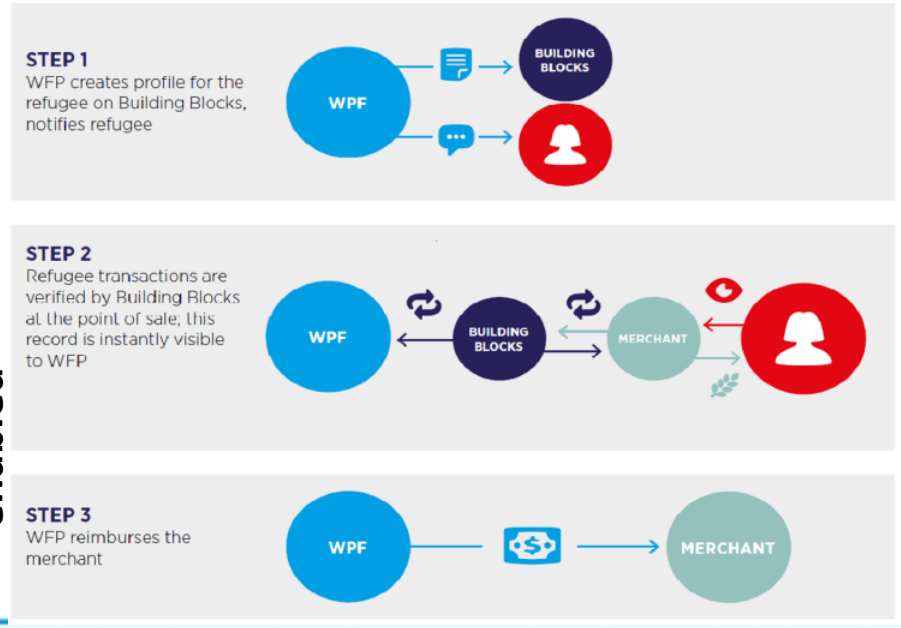
Case Study: WFP Blockchain

- **Problem**: Disbursement of funds to tens of millions of recipients is extensive and at risk of being impacted by fraud or corruption.
- **Need**: A simple yet secure disbursement mechanisms that works for all stakeholders.
- **Obstacle**: Traditional bank-assisted methods are cumbersome and expensive.
- **Solution**: Blockchain-enabled cash assistance.

Traditional



Blockchain-enabled



Source: WFP, 2019.

5. Distributed Ledger Technology (DLT or Blockchain)

Case Study: SOAR Platform

- **Problem**: Drone capabilities are limited by public sector hardware and personnel availability.
- **Need**: Input from private and nonprofit stakeholders.
- **Obstacle**: Challenges in processing and sharing information make this an unlikely resource.
- **Solution**: Use blockchain to facilitate the submission, validation, and presentation of nontraditional drone data.

Image: Screenshot of the Soar Platform.
Source: Soar, 2020.

5. Distributed Ledger Technology (DLT or Blockchain)

▪ Case Study: CDC Use of Blockchain for Public Health Surveillance and Disaster Response

- **Problem**: Public health surveillance requires is a data driven endeavor, including during disasters.
- **Need**: Data reporting by a very high percent of medical professionals.
- **Obstacle**: Data interoperability, safety, and security of centralized database systems.
- **Solution**: Blockchain-based public health data reporting system.

Source: CDC, 2020.

5. Distributed Ledger Technology (DLT or Blockchain)

Case Study: UNICEF Blockchain-based Certificate Tracking

- **Problem**: Individuals are required to prove certification in many instances related to competency or job eligibility.
- **Need**: A system that enables certificate accessibility and validation.
- **Obstacle**: Certificates are not always easy for participants to access and third parties may doubt the veracity of the certificate.
- **Solution**: Blockchain-based certification system linked directly to the certificate issuing agency or organization.

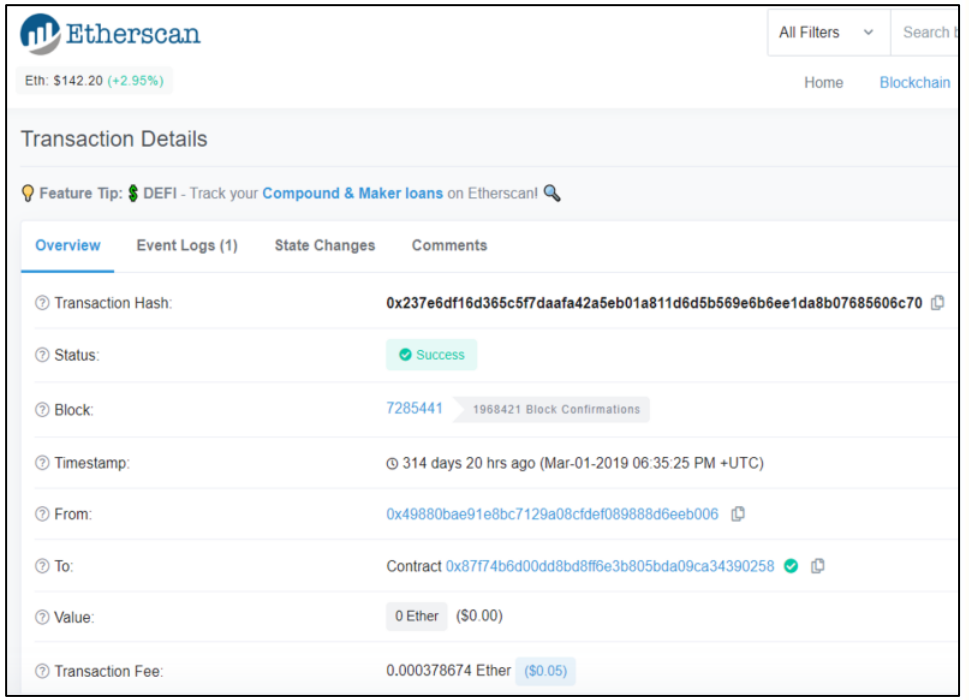


Image: Screenshot of the Ethereum Network-based certification interface.
Source:. UNICEF Ventures, 2020.

Background Materials

Key Readings	· UNDRR. 2019. The Science and Technology Roadmap to Support Implementation of the Sendai Framework for Disaster Risk Reduction 2015-2013. http://bit.ly/2mkomcW. · Shaw, R., L. Lu and F. Lian. 2017. Science Technology Plan for Disaster Risk Reduction: Asian and Pacific Perspectives. ICSU and IRDR. Beijing, China. http://bit.ly/2YLqhIL · Asian Science and Technology Conference for DRR. 2018. Science-Policy Dialogue for Implementation of the Sendai Framework. UNISDR. April. http://bit.ly/2Zzp98f.
Further Readings	· United Nations. 2015. Strengthening the Role of Science and Technology for Disaster Risk Reduction in the Arab Region. United Nations Office for Disaster Risk Reduction. Geneva. http://bit.ly/2YjFBNi


Thank you