Impact of Natural Disasters on Critical Infrastructures

The 1st Bangladesh Earthquake Symposium (BES-1)

Dhaka, Bangladesh

14-15 Dec 2005

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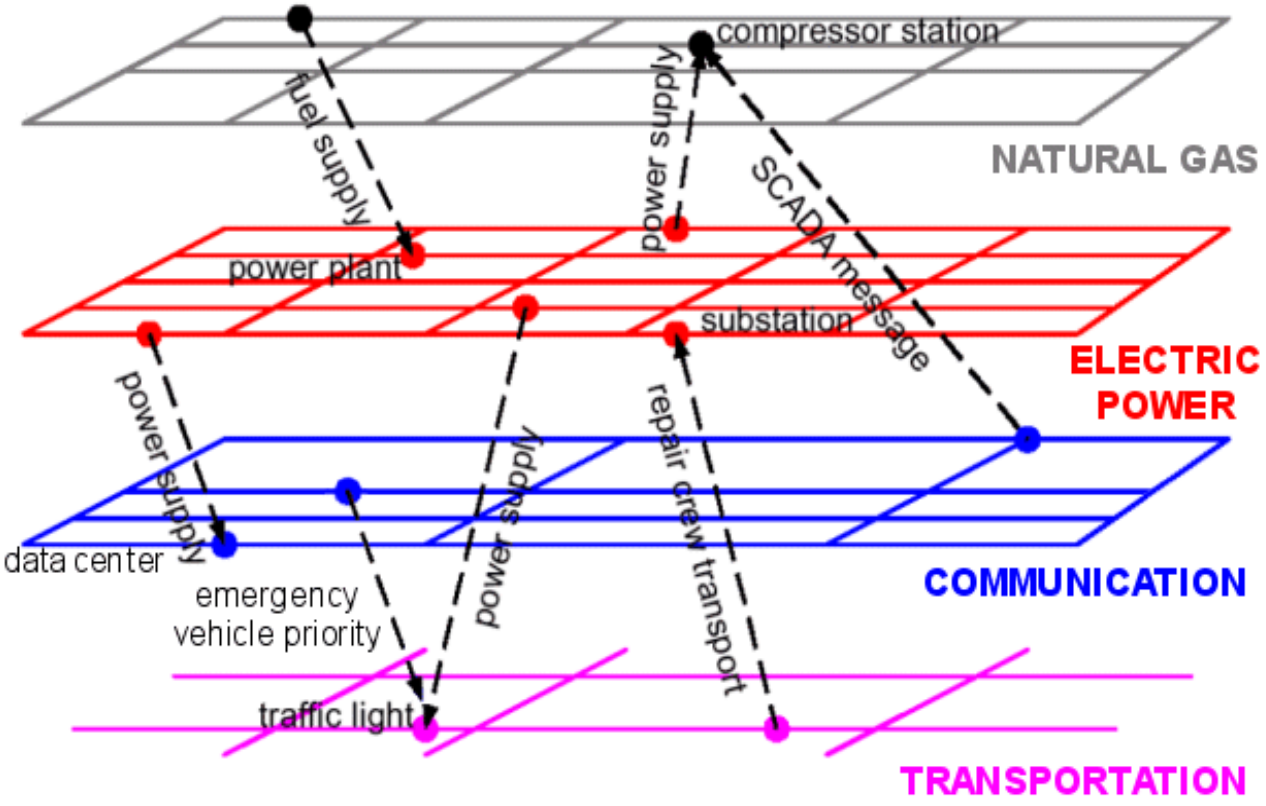
Outline

- Critical infrastructure interdependencies
- Vulnerabilities and cascading failures
  - Kobe Earthquake in Japan, 1995
  - Major Floods in Europe, 2002
  - Hurricane Katrina in the USA, 2005
- Lessons for Bangladesh

What are Critical Infrastructures

- Energy
- Transportation
- Water supply
- Information & communication
- Emergency services
- Law enforcement
- Financial services
- Health care
- Food supply
- High vulnerability industries

Infrastructure Interdependencies



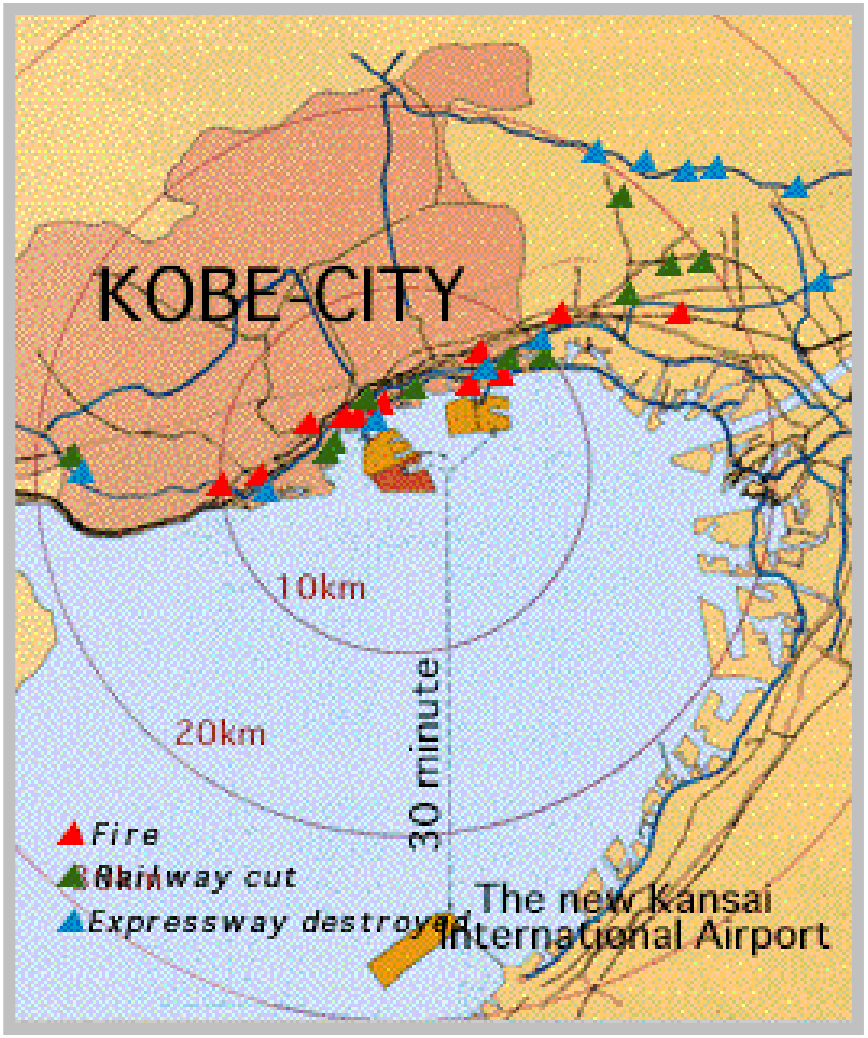
Complex relationships among various critical infrastructure elements result in infrastructure interdependencies

Critical infrastructures are vulnerable to cascading failures

- Natural Hazards
  - Hurricanes
  - Earthquakes
  - Snowstorms
  - Floods
- System Failures
  - Intentional events
  - Equipment Breakdown
  - Human error

Impacts of Natural Disasters

Earthquake Kobe in Japan, January 1995



Magnitude = 7.2 Richter scale

More than 6,000 died

More than 40,000 injured

Estimated Damage = US$200 B

Source: Kathee Terry, NASA

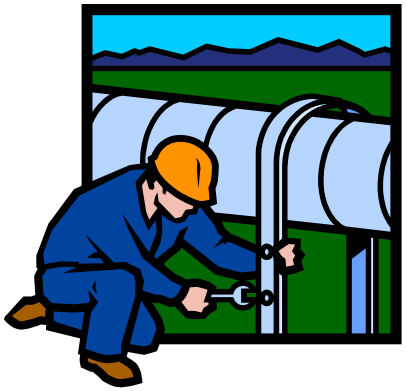
Impact on Critical Infrastructures: Kobe Earthquake, Jan 1995

Effects of the Kobe earthquake in Japan, 1995:

- 240,000+ buildings were destroyed
- 1.3 million were without water
- 2.6 million lost electricity
- 860,000 were without natural gas service
- 300,000 lost telephone services
- Highways and railways broke apart

Damages to gas supply network

- Damaged: 106 medium pressure gas mains
- Damaged: 26,459 low pressure gas service lines
- It took 15 hours to shut-down the system causing many fires
- It took 85 days to restore the natural gas service



Source: Y. Shimizu, F. Yamazaki, R. Isoyama and T. Suzuki, "Super high-density realtime disaster mitigation system for city gas supply with enhanced used of GIS"

Kobe Earthquake 1995

Source: pr.caltech.edu

Source: www.unesco.org

Kobe Earthquake 1995

Source: www.astro.qc.ca

Kobe Earthquake 1995

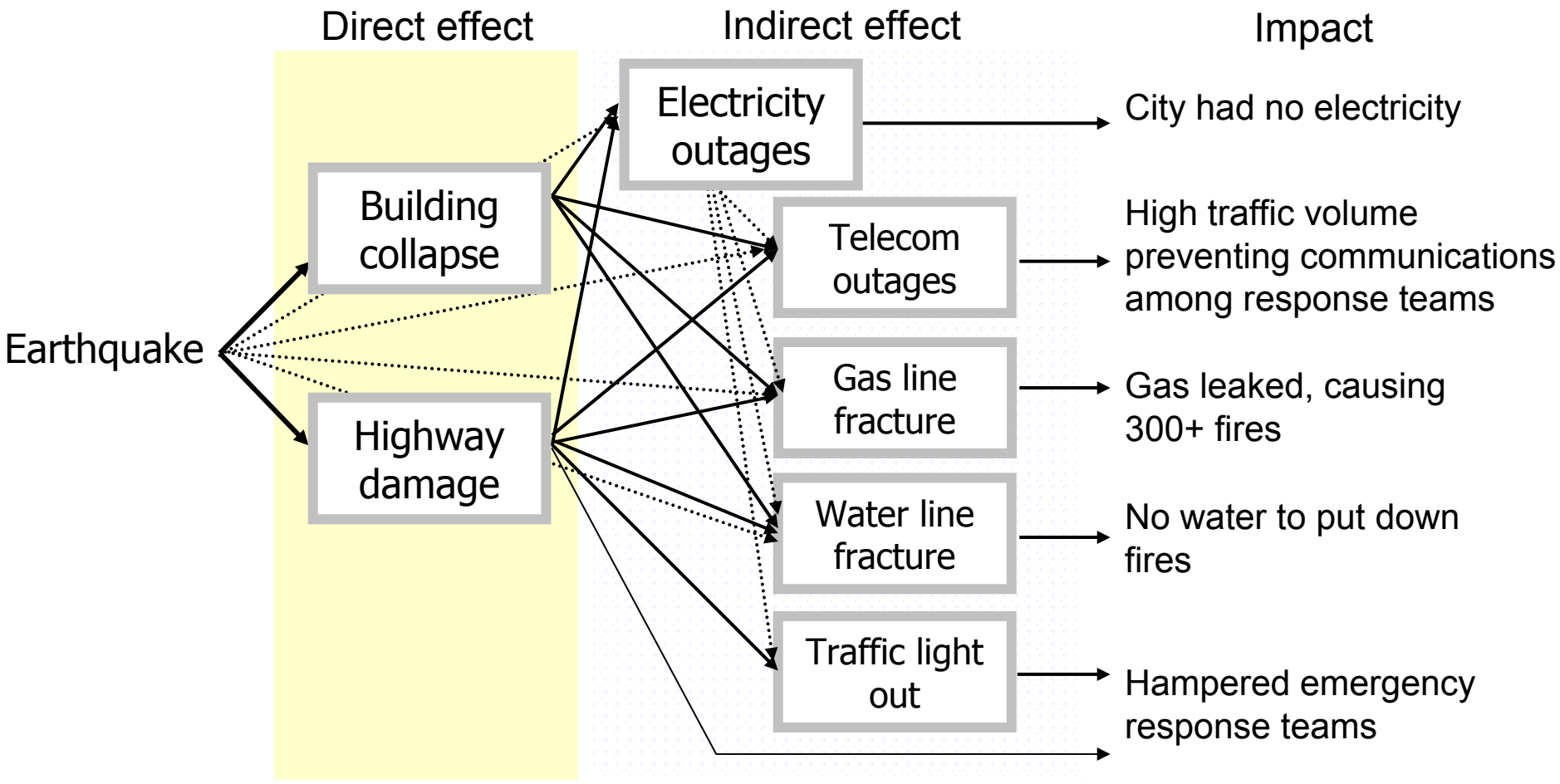
Source: www.mines.utha.edu

Kobe Earthquake 1995

Over 300 fires were ignited by gas leaks from the ruptured pipelines

Source: www.mines.utha.edu

The Kobe Earthquake
A comprehensive example of disasters in urban environment



This earthquake caused a lot of damages to many complex and modern state-of-the-art infrastructures in a metropolitan region

Post-earthquake Policy Changes and Improvements to the Infrastructure

- The Japanese government improved its disaster response policies
- Special disaster prevention routes were designated
- Roads, railways and highways were reinforced
- Earthquake-resistant shelters were built
- Earthquake-resistant pipelines were installed by Osaka Gas Co
- Real-time seismic motion monitoring and gas supply shut-off systems for the network was developed by Tokyo Gas Co.

Recovery time: Electricity & telephone 1 month; water & gas 2-3 months; buildings & roads 6 months+.

A Gas Network Monitoring System

To cope with earthquake related secondary disasters, a new real-time disaster mitigation system for a city gas network was developed by Tokyo Gas Co. starting in 1998.

- Operation started in 2001
- Observe the status of 38,000 district regulators
- Shut them off remotely

This remote-controlled system can achieve quick gas supply shut-off and effectively reduce gas leakage risk during earthquakes.

Major Floods in Europe, Aug 2002

More than 110 died

Estimated Damage Euro15B

Most affected countries:

- Germany
- Czech Republic

Source: Risk Management Solutions, Event Report: Central Europe Flooding, August 2002

Impact on Critical Infrastructures: Major Floods in Europe, Aug 2002

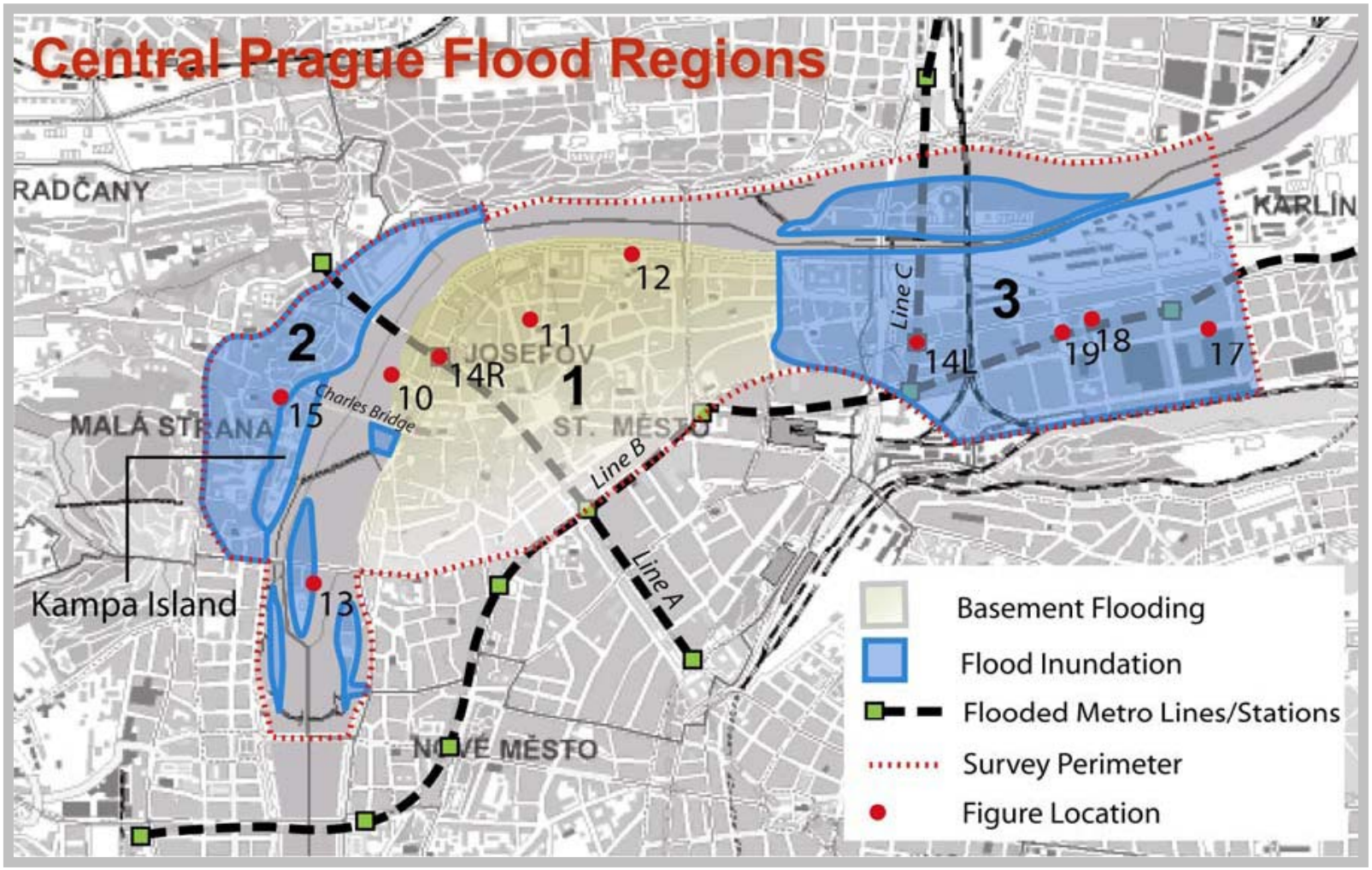
Major infrastructures were severely damaged by high water levels:

- Electricity outages
- Telecommunication links were cut off
- Floods damaged public transportation systems
- 250 roads and 256 bridge structures were damaged
- Gas service was cut since pipelines were damaged
- Clean water contaminated with flooded water

Recovery time:

Electricity 1 month; Gas 2 months; and Telephone 3 months.

Floods in Prague 2002



Source: Risk Management Solutions, Event Report: Central Europe Flooding, August 2002

Floods in Prague 2002

This is an aerial view of the swollen rivers Berounka, left, and Vltava as they flooded a huge area near Zbraslav on the outskirts of Prague.

Source: www.esa.int

Floods in Prague 2002

A metro station in Prague

Floods on roads and highways

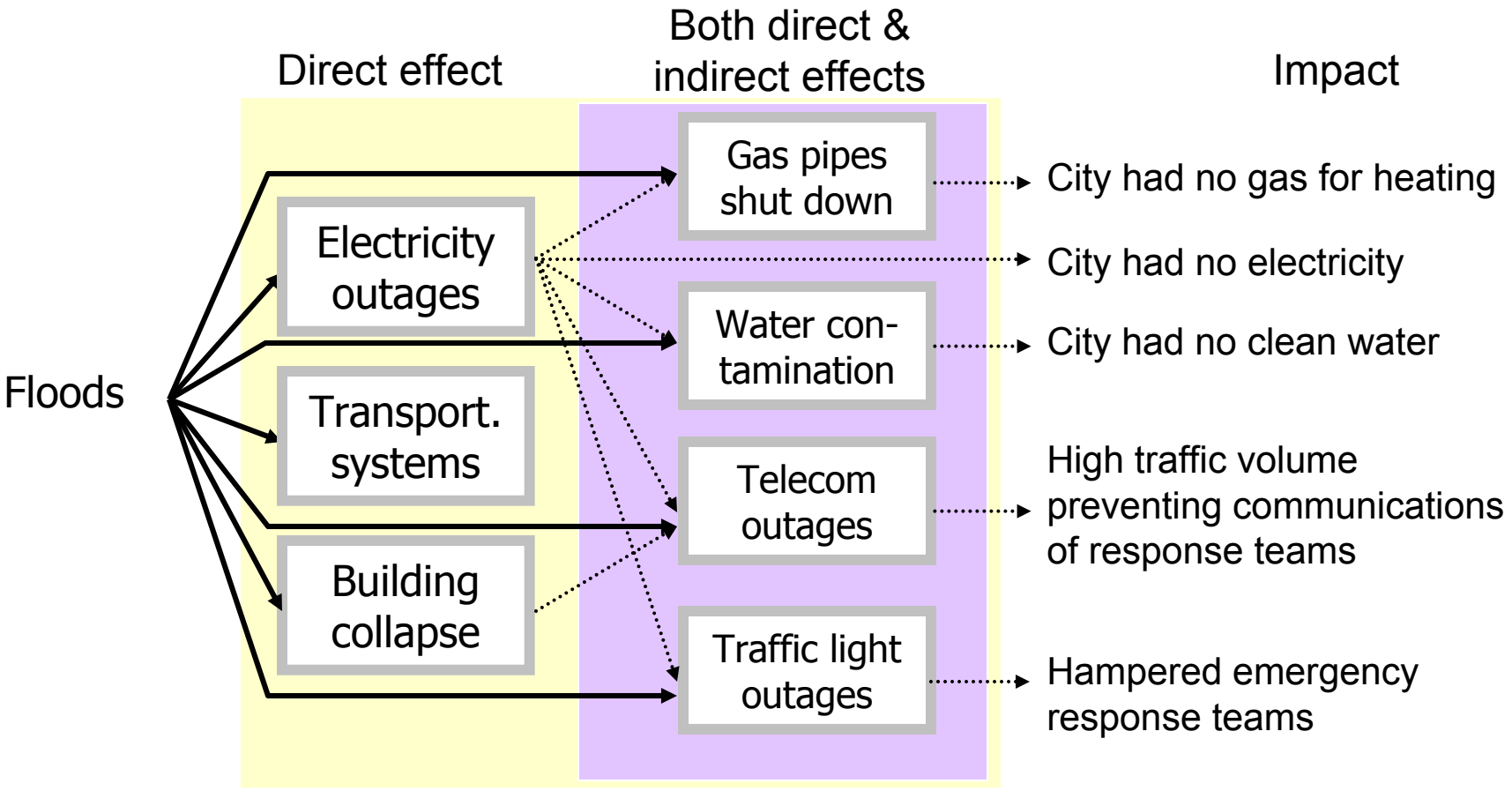
Source: Risk Management Solutions, Event Report: Central Europe Flooding, August 2002
Source: Prague TV

Floods in Prague 2002

A multi-story building collapsed because of floods

Source: Risk Management Solutions, Event Report: Central Europe Flooding, August 2002

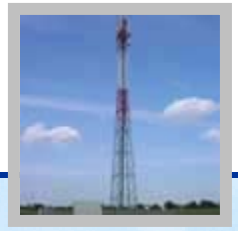
The major floods in Europe damaged all critical infrastructures, but mobile GSMs survived



Mobile GSMs were the only communications means available for the rescue teams, however, the traffic volume was very high

Communications during the flood situation

- Mobile GSMs were the only communications means available.
- About 20,000 GSMs were distributed among rescue teams and state administrators.
- SMS messages were used to provide emergency phone numbers.
- To prevent overloading of mobile networks, mobile transceiver stations were put in key endangered areas.
- These mobile stations were powered by mobile gas/diesel gensets.
- T-mobile put up 31 generators in Prague; Eurotel used 66 gensets for its 100 key base stations.

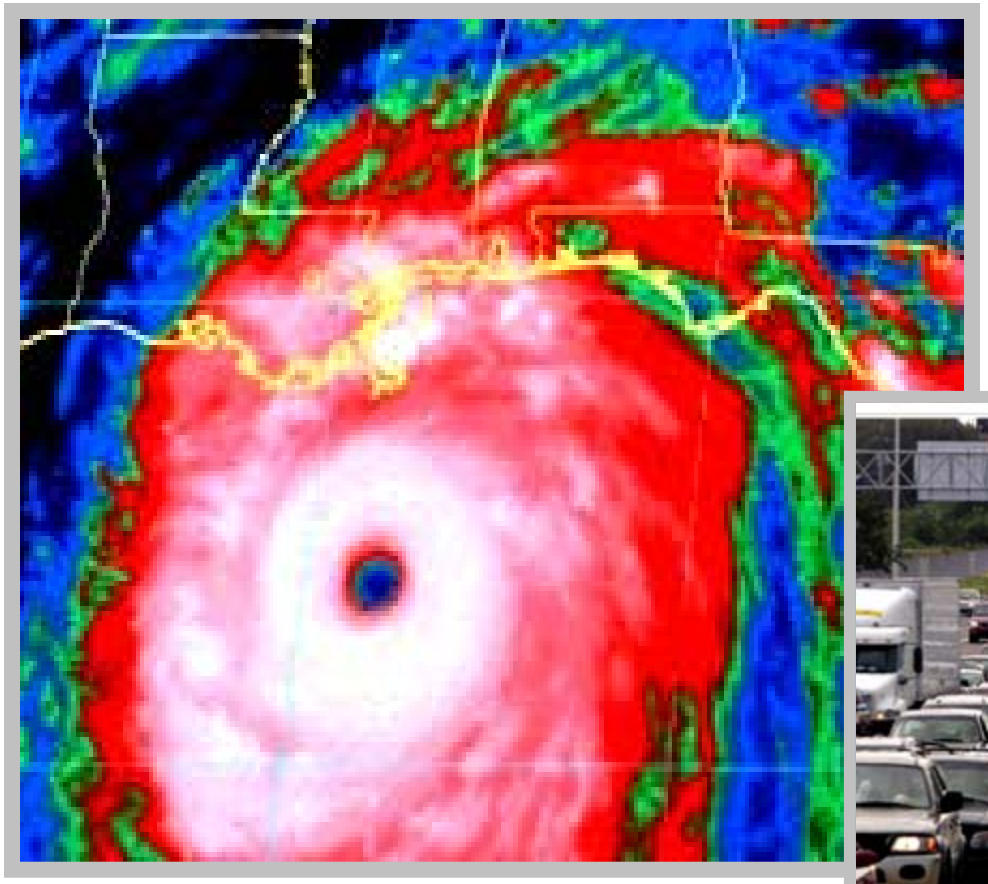


Strategies Developed in Czech Republic

- Developed a flood simulation system, known as LISFLOOD
- Established Ministry of Informatics on Jan 1, 2003 as a central government body for ICT
- Improvements made in the department of crisis management
- Improvements made in the Czech telecommunication office
- Implemented International Emergency Preference Scheme (IEPS) in accordance with ITU E.106

What is IEPS: IEPS = International Emergency Preference Scheme. IEPS will provide authorized users priority access to telecommunication services and priority processing of communications in support of recovery operations during emergency events.

Hurricane Katrina in the US, Sept 2005



People were evacuating as Hurricane Katrina heading for the Gulf Coast

Source: www.time.com

Hurricane Katrina, 2005

80% of the city is left under water with no power, no drinking water, telephone or food supply.

Estimated damage = US$ 200B

Physical damage to major infrastructures

- Electric power
- Natural gas & oil
- Transportation
- Water
- Telecom
- Banking and finance
- Emergency service

Source: www.abc.net.au

Hurricane Katrina, 2005

- 2.3 million homes were without power
- Nationwide interruptions in distribution of oil and gas
- 1.6 million customers were without telephone services in LA
  - Telecom switches were run on generators
  - Telecom terminals were run on batteries
  - Internet services were down

Source: www.abc.net.au

Hurricane Katrina, 2005

Floodwaters from Hurricane Katrina fill the streets of New Orleans

Source: www.abc.net.au

Hurricane Katrina, 2005

Electricity poles nearly pushed to the ground by Hurricane Katrina

Source: www.abc.net.au

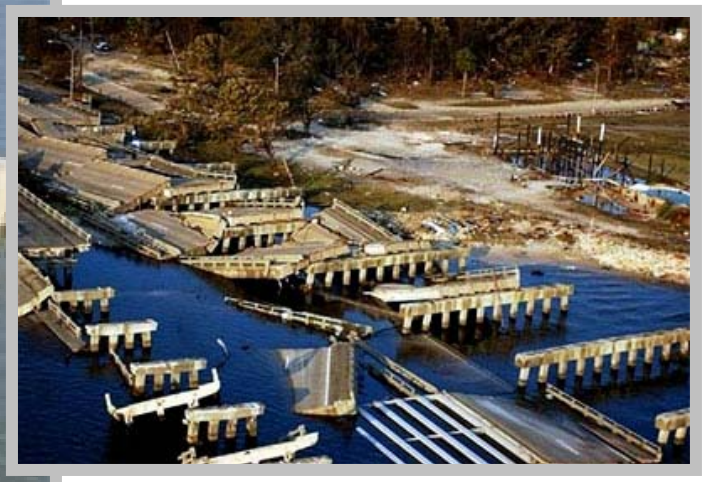
Hurricane Katrina, 2005

Gulf of Mexico oil rig, damaged by Hurricane Katrina

An oil refinery is submerged in water in Alabama in the aftermath of Hurricane Katrina.

Source: www.abc.net.au

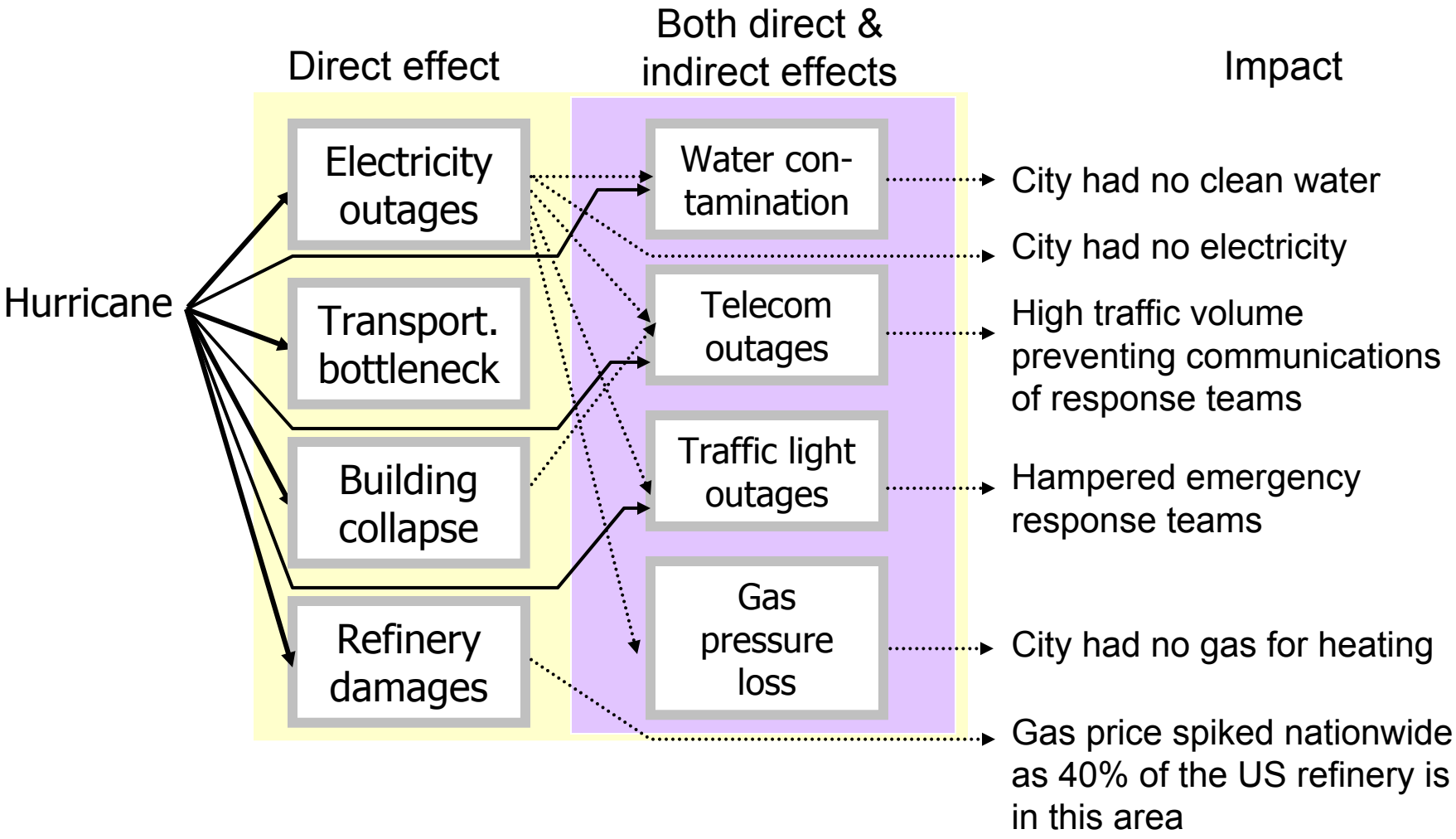
Hurricane Katrina, 2005



A destroyed bridge and road

Source: www.katrinahelp.com

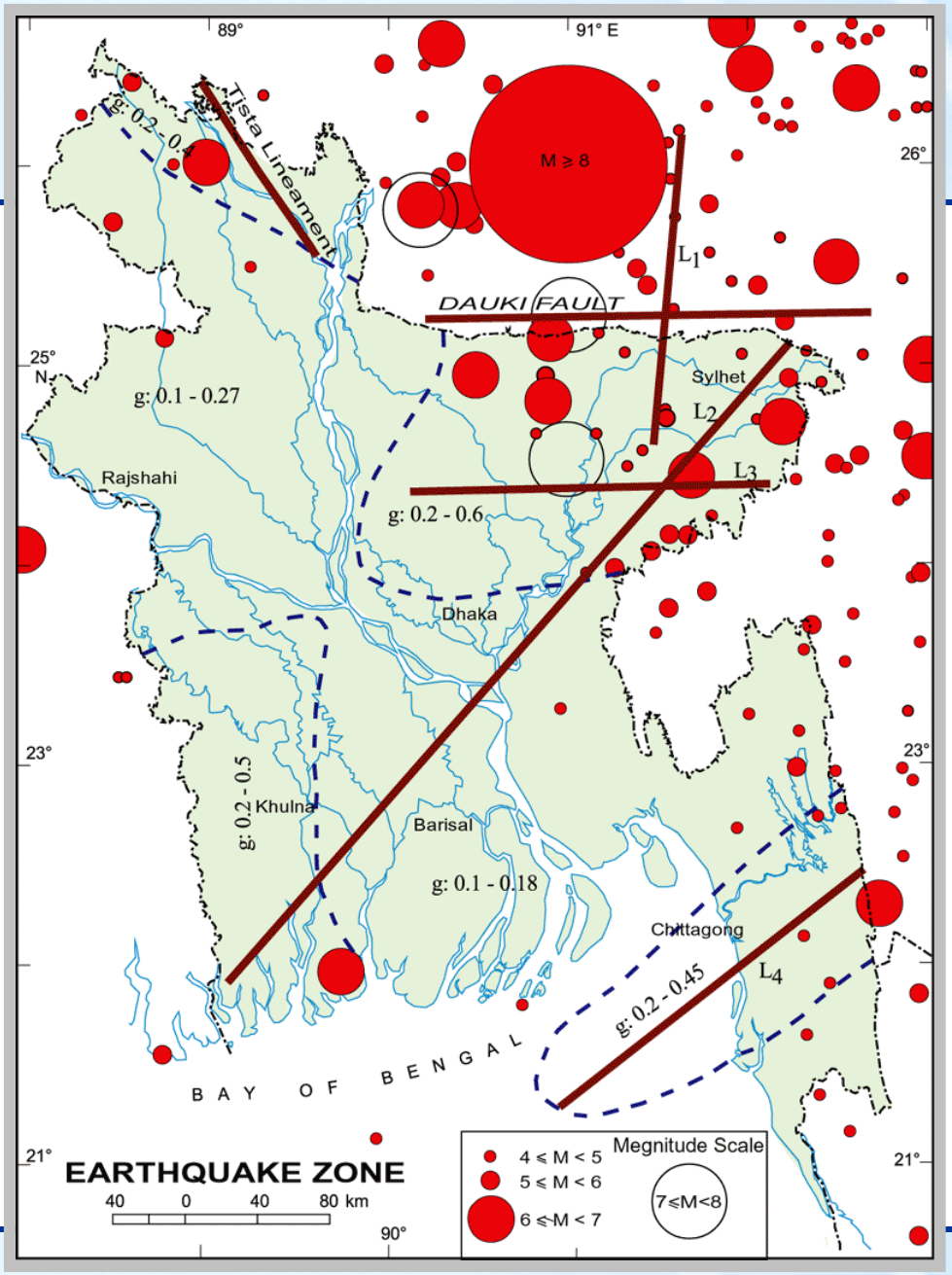
Hurricane Katrina damaged all critical infrastructures, but mobile GSMs survived (again)



Mobile GSMs were (again) the only communications means available for the rescue teams, however, the traffic volume was very high

Telecommunications after the hurricane

- Undamaged cellular towers were operated on backup generators.
- Mobile phone traffic was limited due to congested networks.
- Mobile phones used by rescue teams ran out of battery.
- Mobile transceiver stations and backup generators were used.
- Nearly 10,000 satellite phones were distributed for relief efforts.



Source: http://banglapedia.search.com.bd/HT/E_0002.htm

Lessons for Bangladesh

- Bangladesh is highly vulnerable to seismic activity
- Dhaka is among the 20 most vulnerable cities in the world
- The magnitude averaging around 5 in Richter scale
- In addition, floods are recurring phenomena

Q: What the likely consequences would be if an earthquake comparable to Kobe were to strike Dhaka?

Earthquake chronology (1885-2003)

Year	Name	Date	Magnitude	Epicenter
1885	Bengal earthquake	14 July	M=7.0	Manikganj
1889	-	10 Jan	M=7.5	Jaintia Hills
1897	Great India Earthquake	12 Jun	M=8.7	Shillong Plateau; death toll = 545; total damage = Rs 9,000
1918	Srimangal Earthquake	18 Jul	M = 7.6	Srimangal, Maulvi Bazar
1930	Dhubri Earthquake	3 Jul	M= 7.1	Dhubri, Assam

Earthquake chronology, contd. (1885-2003)

Year	Name	Date	Magnitude	Epicenter
1934	Bihar-Nepal Earthquake	15 Jan	M = 8.3	Darbhanga of Bihar, India
	-	3 Jul	M = 7.1	Dhubri of Assam, India; damages in Rangpur district of Bangladesh
1950	Assam Earthquake	15 Aug	M = 8.4	Assam, India
1997	-	22 Nov	M = 6.0	Chittagong
1999	-	22 Jul	M = 5.2	Maheshkhali Island
2003	-	27 Jul	M = 5.1	Kolabunia union Barkal upazila, Rangamati district

Lessons for Bangladesh

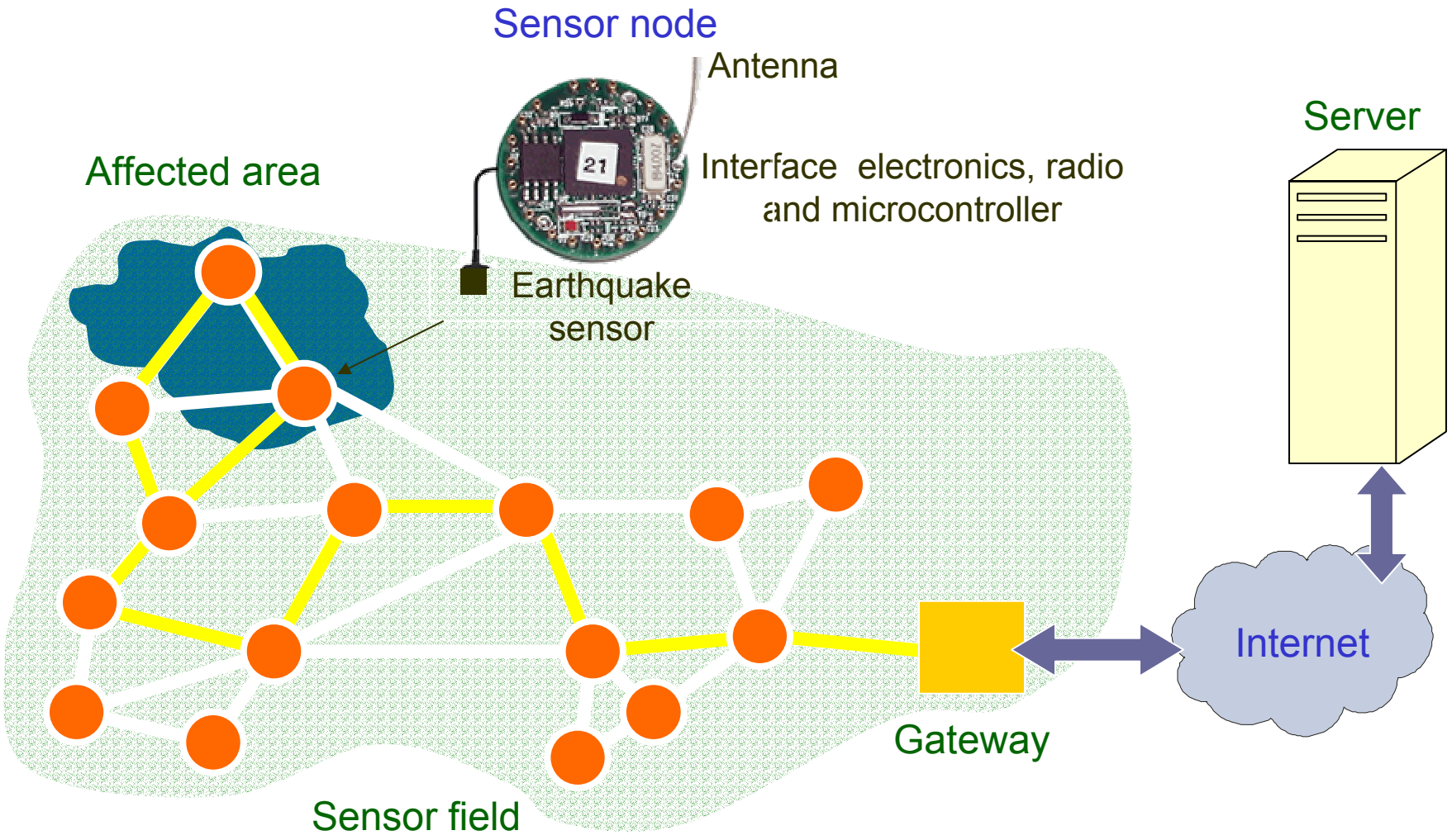
1. Emphasis on early warning and monitoring systems
   - Disaster monitoring networks to generate early warning signals
   - SCADA networks to monitor and control each critical infrastructure

For example, SCADA, together with automated shut-off valves could be installed in the gas pipeline network. Once a disaster event is detected, engineers will be able to control these valves.

Similar safety algorithms can be used to control water flow, electric power and highway traffic.

The structure of each critical infrastructure must be analyzed in order to identify appropriate control points.

SCADA Sensor Network



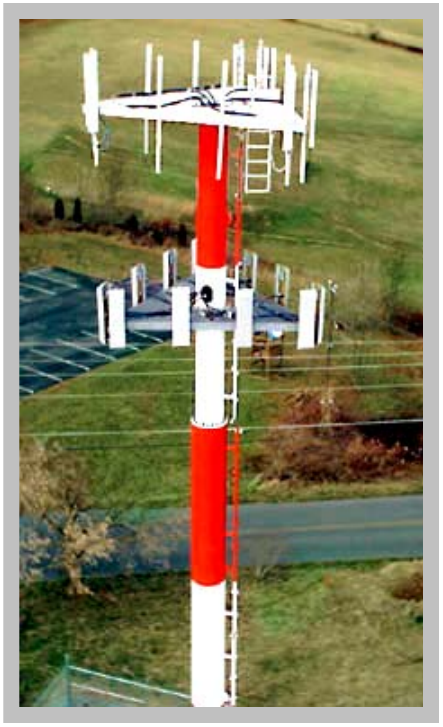
Lessons for Bangladesh

2. Emphasis on ensuring that key response systems remain functional

It is necessary to ensure all critical elements, especially communications networks, needed to effectively dispatch emergency response crews remain functional.

The floods in Europe and the U.S. revealed this weakness when communication networks encountered severe damages.

Mobile base stations and backup generators must be pre-supplied with sufficient backup fuel.



Lessons for Bangladesh

3. Emphasis on response planning and coordination among agencies

Kobe earthquake highlighted the need for collaboration among agencies at all levels, including public-private partnerships.

Some of the best practices:

- The development of collaborative community response plans
- The development of mutual agreements among relevant agencies
- The routine practice of multi-jurisdictional exercises and drills.

Thank you

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Questions or Comments?