UbiFLOOD project

Ubiquitous computing in flood warning and forecasting systems

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Outline

- Objectives, strategy & partners
- Flooding in Asia
- SCADA & Ubiquitous computing
- How can be implemented?
- Illustration with use case
- Conclusions and perspectives

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Project [1/2]

- UbiFLOOD project deals with implementation of ubiquitous computing in flood warning and forecasting systems in different Asian background.
- The common characteristics for selected cities are that they are in monsoon region and that they face historical flooding problems.
- Populations request information about flood processes.
- Cities have very different Information Systems and use different communication architectures & devices.

Project [2/2]

Vision: Rethink the warning systems & SCADA architectures with the Ubiquitous approach

Objectives

Promote

- New middleware research for ubiquitous computing emerging in France and Europe

Explore

- Explore development of new devices adapted to the different Asian environments (mobile devices, communication network, data acquisition disposals, real time data treatment and means for public awareness)

Develop

- Develop and structure collaboration between France and Asian partners on ubiquitous computing for flood warning and forecasting systems

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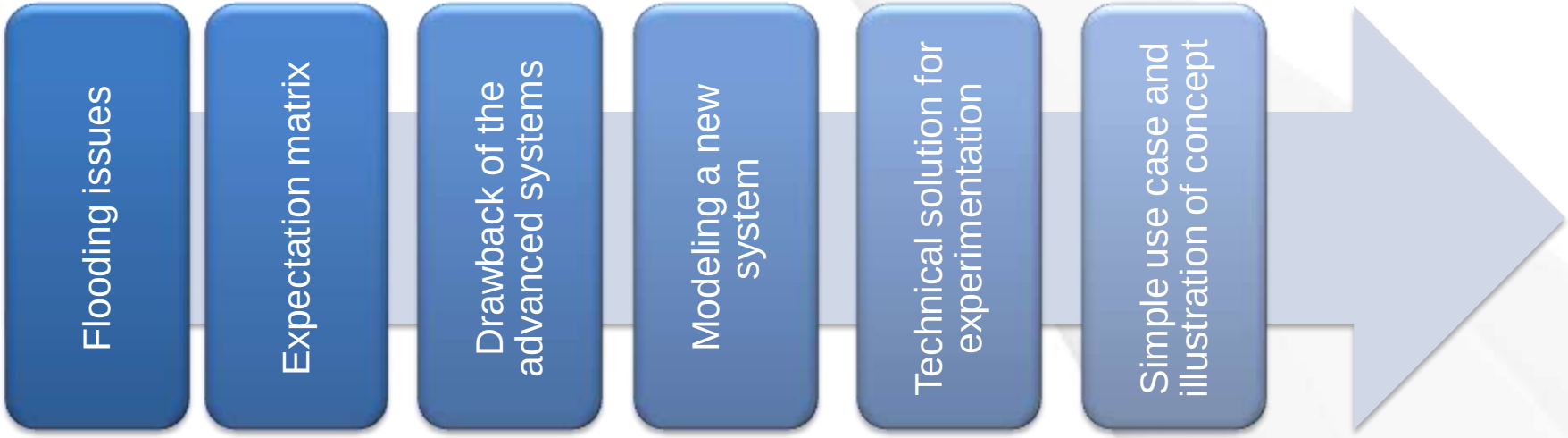
Project partners

Asian partners

French partners

Strategy

- UbiFLOOD project will develop framework to assess better and faster transfer of information to population regarding flooding. Necessity for this research comes from huge losses of lives during and after flood especially in Asia.



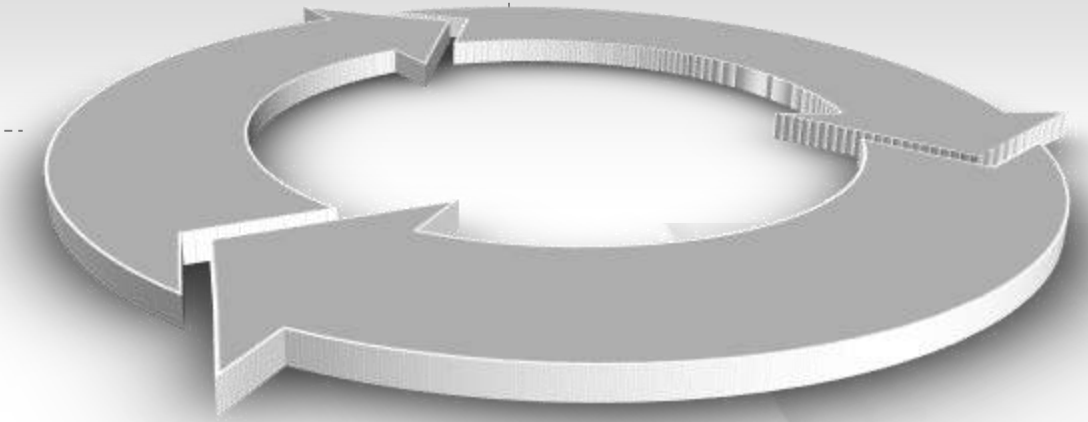
Flooding in Asia

Challenges

The most flood prone area in the world, size of catchments and rivers

Growing urbanization and land use changes

Extreme rainfall events, monsoon



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Case study Bangkok

Precipitation, flood duration flood type, vulnerability assesment

- Average percipitation:1200 – 1400 mm/year, mostly during monsoon period. Proximity of events with precipitation higher than 100mm/h are one event per year.

- Flood duration is several hours where affected area is 20% of total case study area
- City is under existing flood management plan. High vulnerability regarding flood is in: water supply network and transportation network

- Existing flooding is due to: sea level rise (indirect), river flooding, flash floods (high rainfall and inadequate drainage capacity)

Case study Mumbai

Precipitation, flood duration flood type, vulnerability assesment

- Average precipitation is 2300 mm/year; during monsoon period. Proximity of events with precipitation higher then 100mm/h are three event per year.

- Flood duration is several hours with flood extension on 20% of case study area
- City is under existing flood management plan. High vulnerability regarding flood is in water supply network and transportation network

- Existing flooding is due: high precipitation and inadequate capacity of drainage system

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Case study Singapore

Precipitation, flood duration flood type, vulnerability assesment

- Average precipitation is 2400 mm/year; mainly during monsoon period. Proximity of events with precipitation higher then 100mm/h are one event per month.

- Flood duration is 30 to 90 min in localized areas
- City is under existing flood management plan with operationaly just for extreme events. High vulnerability regarding flood is in water supply network, communication and electricity network

- Existing flooding is due: high precipitation and inadequate capacity of drainage system

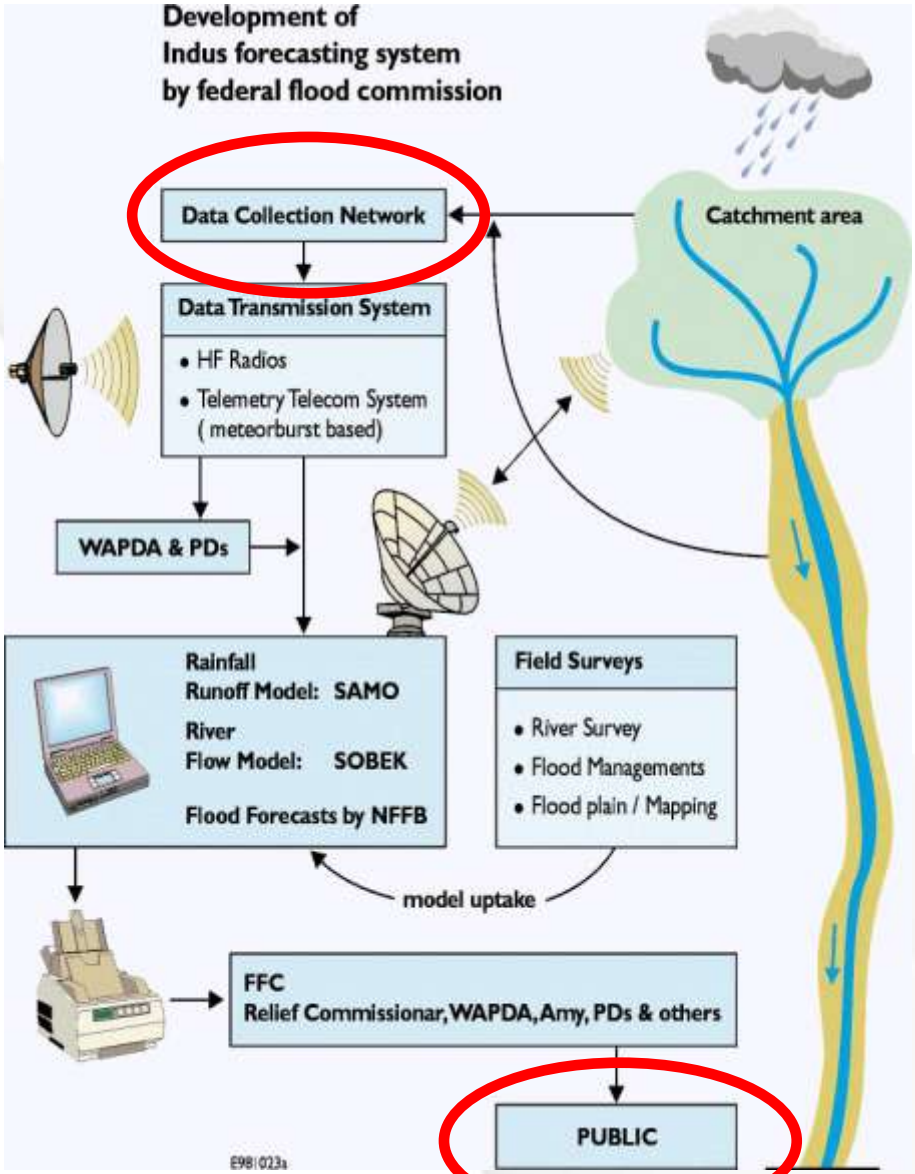
Case studies synthesis

- Cases study analysis showed that flooding mainly occurs during monsoon period, from June to October.
- Proximity of rain events higher then 100mm/h is:
  - Bangkok – one event per year
  - Mumbai – three events per year
  - Singapore – one event per month
- Flooded areas are from very localized up to 20% of case study
- Disaster response systems



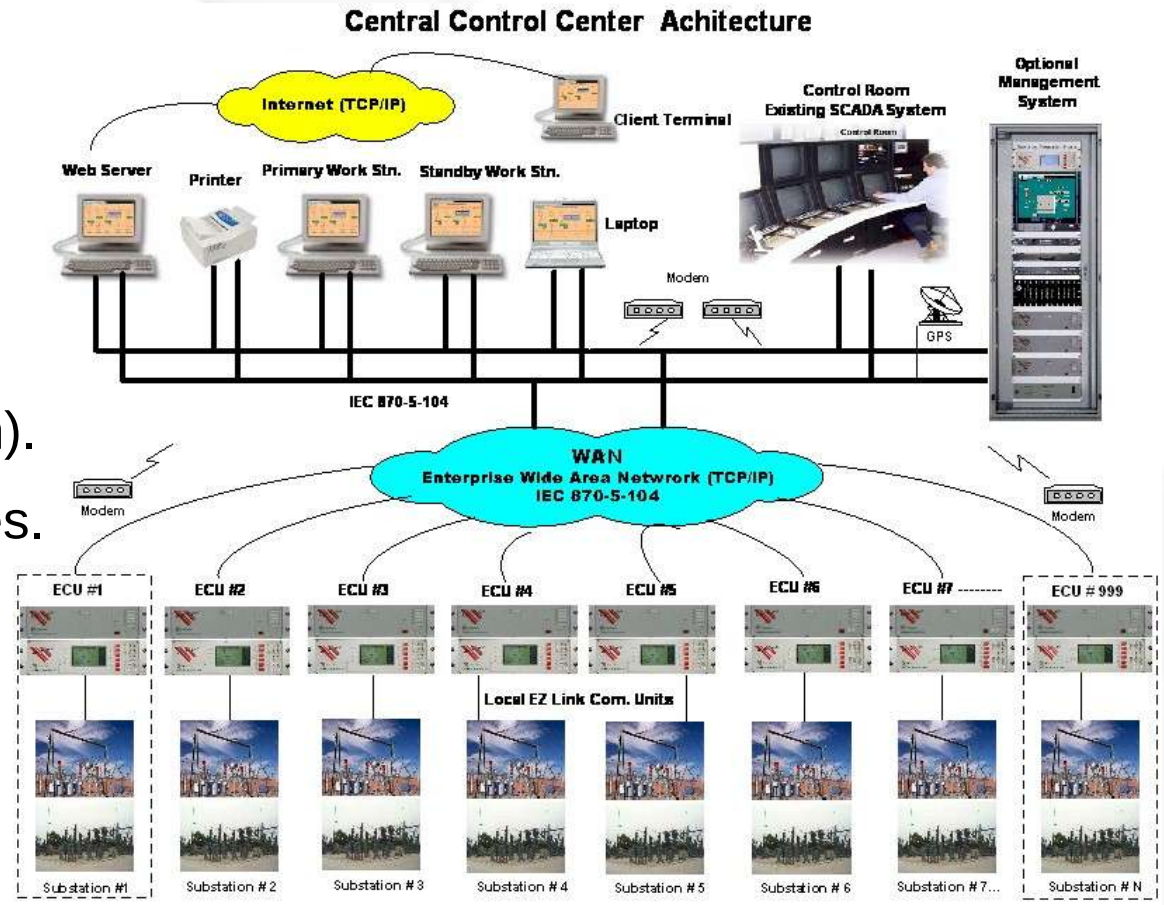
Warning Systems & SCADA [1/2]

- Centralized approach (from data collection to public information)
- Complex architecture with dedicated & specific devices (close system)
- Complex decision making process (request time)
- Limited redundancy in sensors and communication devices
- Inefficient in urban environments (too slow & too late)



Warning Systems & SCADA [2/2]

- Supervisory Control and Data Acquisition.
- SCADA systems are used to monitor and control a plant or equipment in industries such as telecommunications, water and waste control, energy, oil and gas refining and transportation.
- Architecture duplicated for flood warning systems.
- Centralized concept.
- Difficulty to manage technical evolution (sensors & communication).
- New generations of devices.



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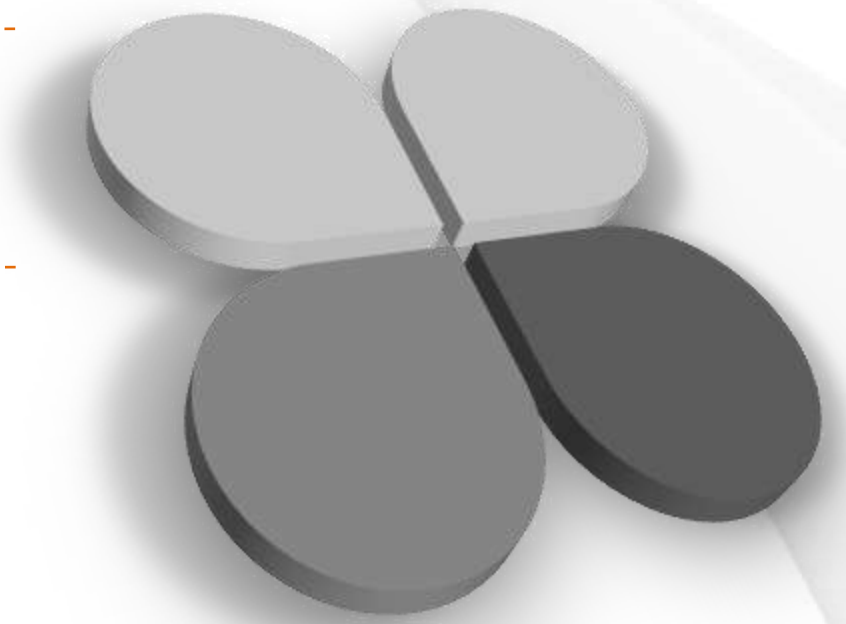
Ubiquitous computing [1/2]

A shift of paradigm: from centralized to ubiquitous architecture

Post-desktop model of human-computer interaction

Engages many computational devices and systems simultaneously

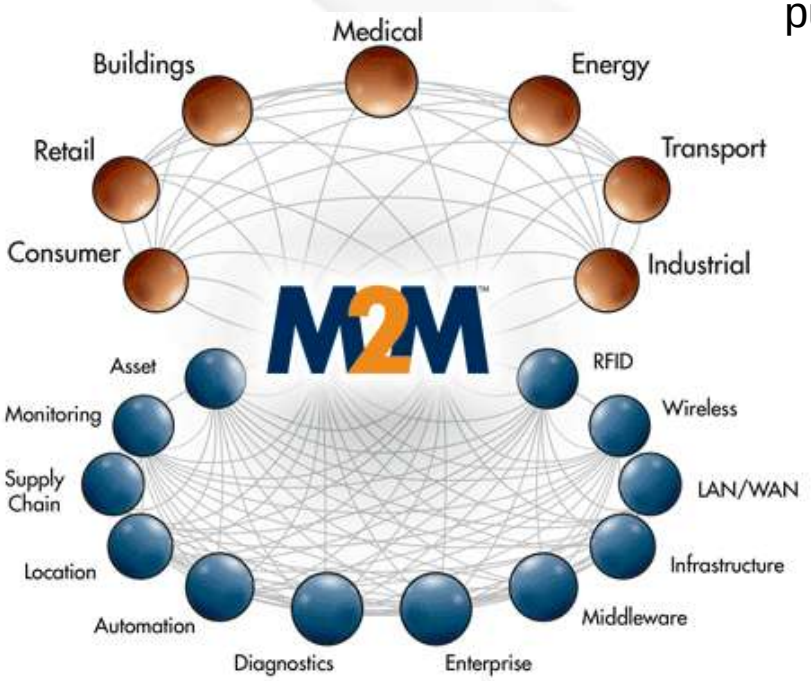


Information processing has been thoroughly integrated into everyday objects and activities

Presents challenges across computer science: in systems design and engineering, in systems modelling, and in user interface design

Ubiquitous computing [2/2]

- Start as a vision
- Today, reality and business (Machine to Machine (M2M))
- Internet of Things



- Completely opportunistic approach to retrieve information from the field and send alerts to the public

- *"Silicon-based information technology, is far from having become part of the environment. "*

Mark Weiser, Scientific American,Vol.265 N.9,pp.66-75,1991

- Make the most of existing devices on the field
- A way to warn people more spontaneously and without delay

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Ubiquitous Computing & new software challenges

Ambient Intelligence

↳ Ubiquitous Computing

↳ **Middleware** to adapt software applications to context variations

The challenges of adaptive middleware are :

- to maintain the consistency of the software applications
- to deal with variablity and complexity of the context
- to control dynamic adaptation to maintain stable and usable applications (adaptation at the right time, with a minimum response time)
- to work at a suitable level of abstraction

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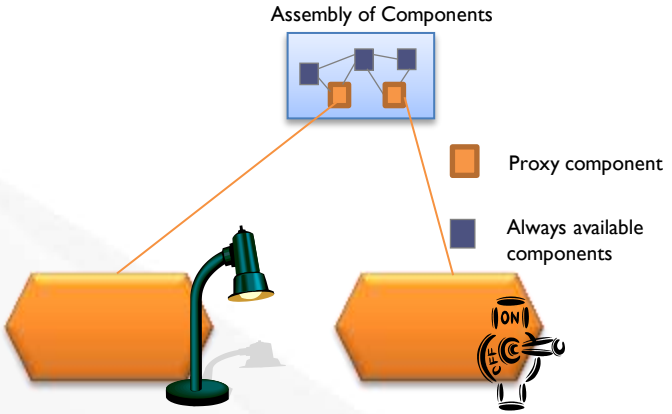
Middleware & software composition for Ubiquitous Computing

- Middleware and software composition models request:
  - Runtime adaptation
  - Context awareness
- **Dynamic composition Model** using components assemblies and services for device.

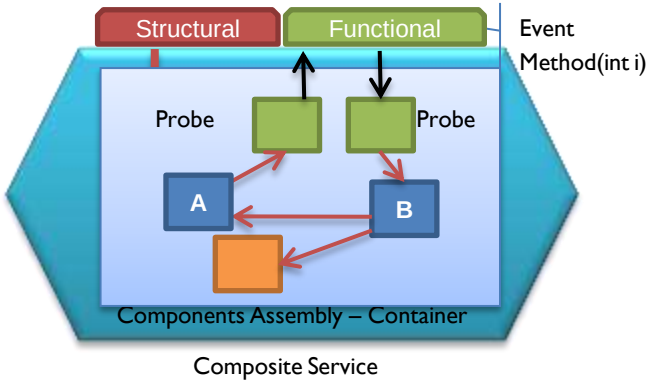
- **Model of independent and dynamic adaptations** triggered by context variations in order
  - to preserve the **consistency** of the application
  - to control the **reaction time** to context changes

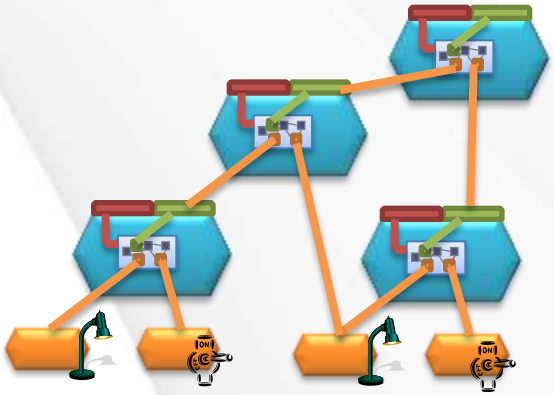
Dynamic composition : SLCA Model

- Dynamic composition of services of device using components assemblies (LCA Model)
  - Event flows
  - Local assemblies of lightweight components



- Composition of Composite Services (SLCA model)

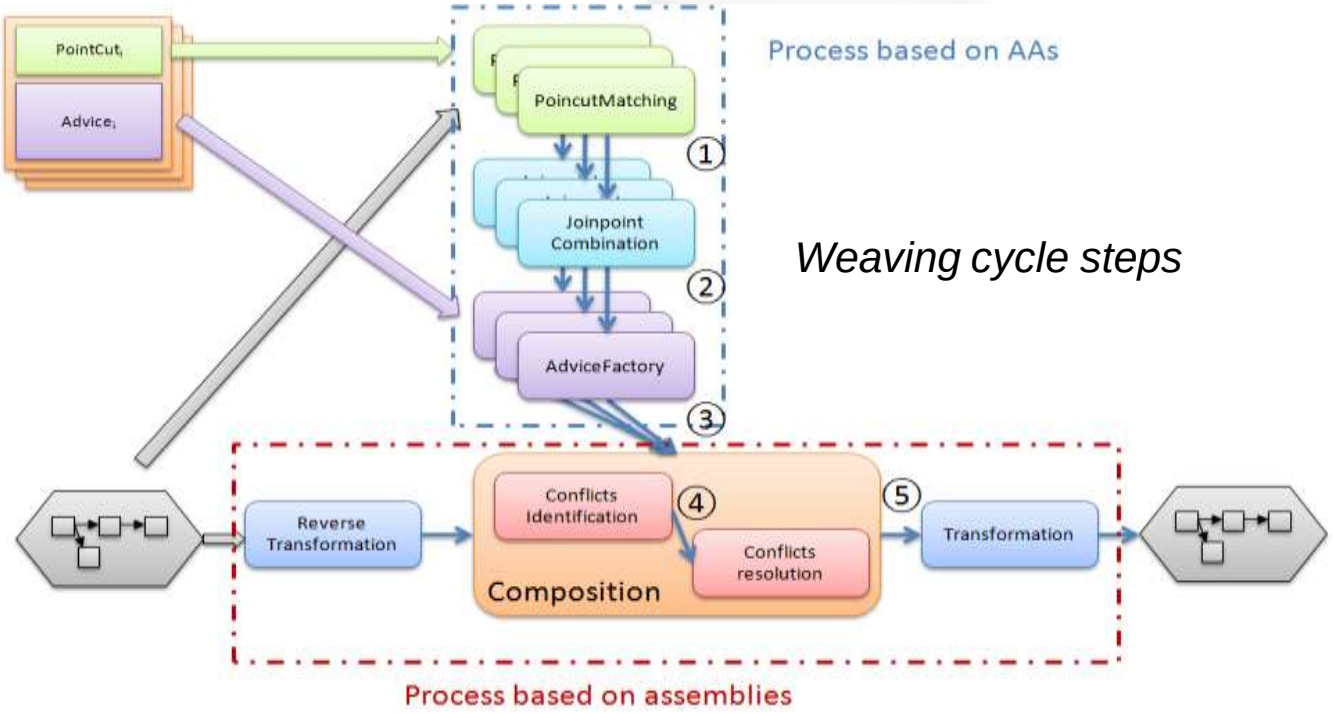




[2009] J.-Y. Tigli, S. Lavirotte, G. Rey, V. Hourdin, M. Riveill, “Lightweight Service Oriented Architecture for Pervasive Computing” IJCSI International Journal of Computer Science Issues, Vol. 4, No. 1, September 2009, ISSN (Online): 1694-0784, ISSN (Print): 1694-0814

Dynamic and independent adaptations : AA Model

- Independence : Aspect of Assembly (AA)
  - Using Aspects for the modification of component assemblies
- Dynamicity: Adaptation to the context
  - Triggering of weaving cycle of AA on context changes



[2009] J.-Y. Tigli, S. Lavirotte, G. Rey, V. Hourdin, D. Cheung, E. Callegari, M. Riveill "WComp middleware for ubiquitous computing: Aspects and composite event-based Web services" in the Annals of Telecommunications journal , Springer editor Paris, ISSN 0003-4347 (Print) 1958-9395 (Online), Vol. 64, No 3-4, March-April 2009

Adaptation validation - Consistency

- Validation of logical properties in the weaving process :
  - Methodology : proven composition mechanisms between components with a known semantic :

    Using merging rules (Ph. D. theses of D.Cheung [2008] and V. Hourdin [2010])

    Automata composition (in collaboration with A. Ressouche [INRIA] on synchronous approaches and model checking)
- Example :
  - Symmetry property of the weaver :

Commutativity : $AA0 \otimes AA1 = AA0 \otimes AA1$
Associativity : $(AA0 \otimes AA1) \otimes AA2 = AA0 \otimes (AA1 \otimes AA2)$
Idempotence : $AA0 \otimes AA0 = AA0$

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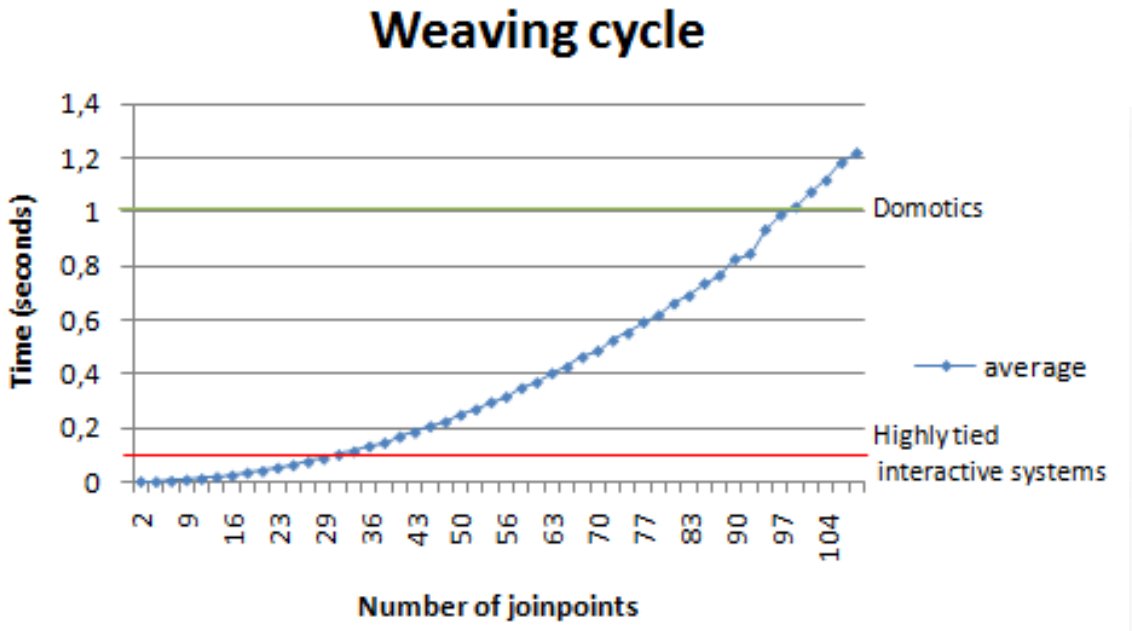
Validation of adaptation - reaction time

- Performance evaluation in dynamic adaptation
- Methodology :
  - Analysis of complexity of the different algorithmic steps
  - Model and identification of parameters in the performance analysis



Flood warning system requirements and challenges

- Two cases for existing Flood Warning Systems (FWS):
  - » Case 1: without sensors and information systems
  - » Case 2: with sensors in the field and information systems

	Global network system for the FWMS
Bangkok	Heterogeneous networks
Mumbai	No
Singapore	Heterogeneous networks

	Type of network connection for devices
Bangkok	Radio frequency , fiber-optic, GPRS
Mumbai	/
Singapore	Wireless

	Devices to collect data on the ground
Bangkok	Water level sensor
Mumbai	/
Singapore	Wireless water level sensor

	Public Devices to inform the population
Bangkok	Public display using big screen televisions at streets junctions, traffic screen at bus stations
Mumbai	Public display using sign boards at streets junctions
Singapore	public display, public audio alert system, public broadcasting system...

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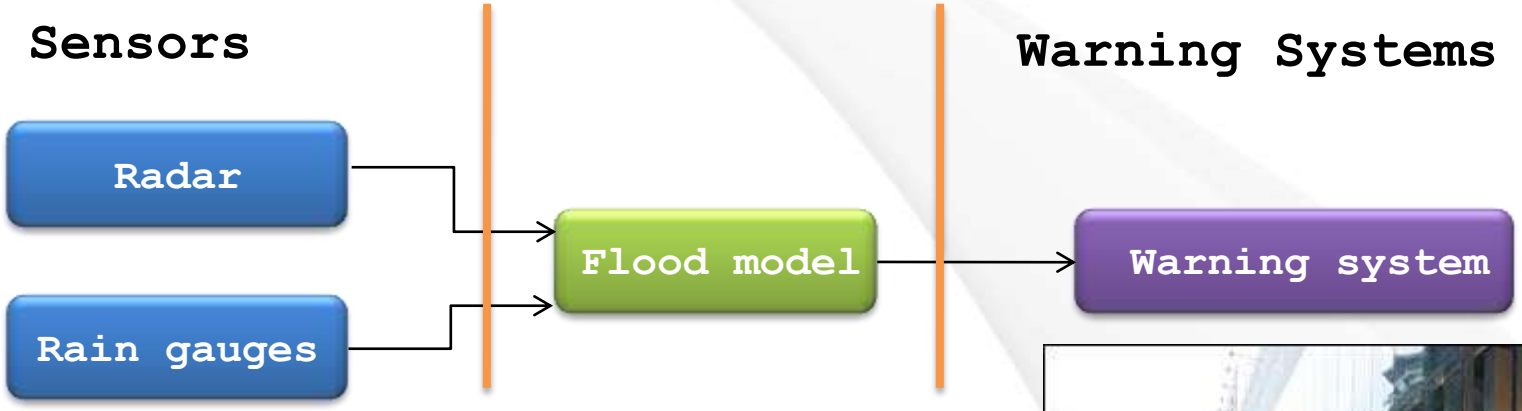
Existing Flood Warning Systems and their drawbacks

- Structure of most advances Flood Warning systems (FWS) :



- Downside: slow and not reliable
- Some model may take 15 hours to produce results and need some manual intervention!

Singapore, 2010

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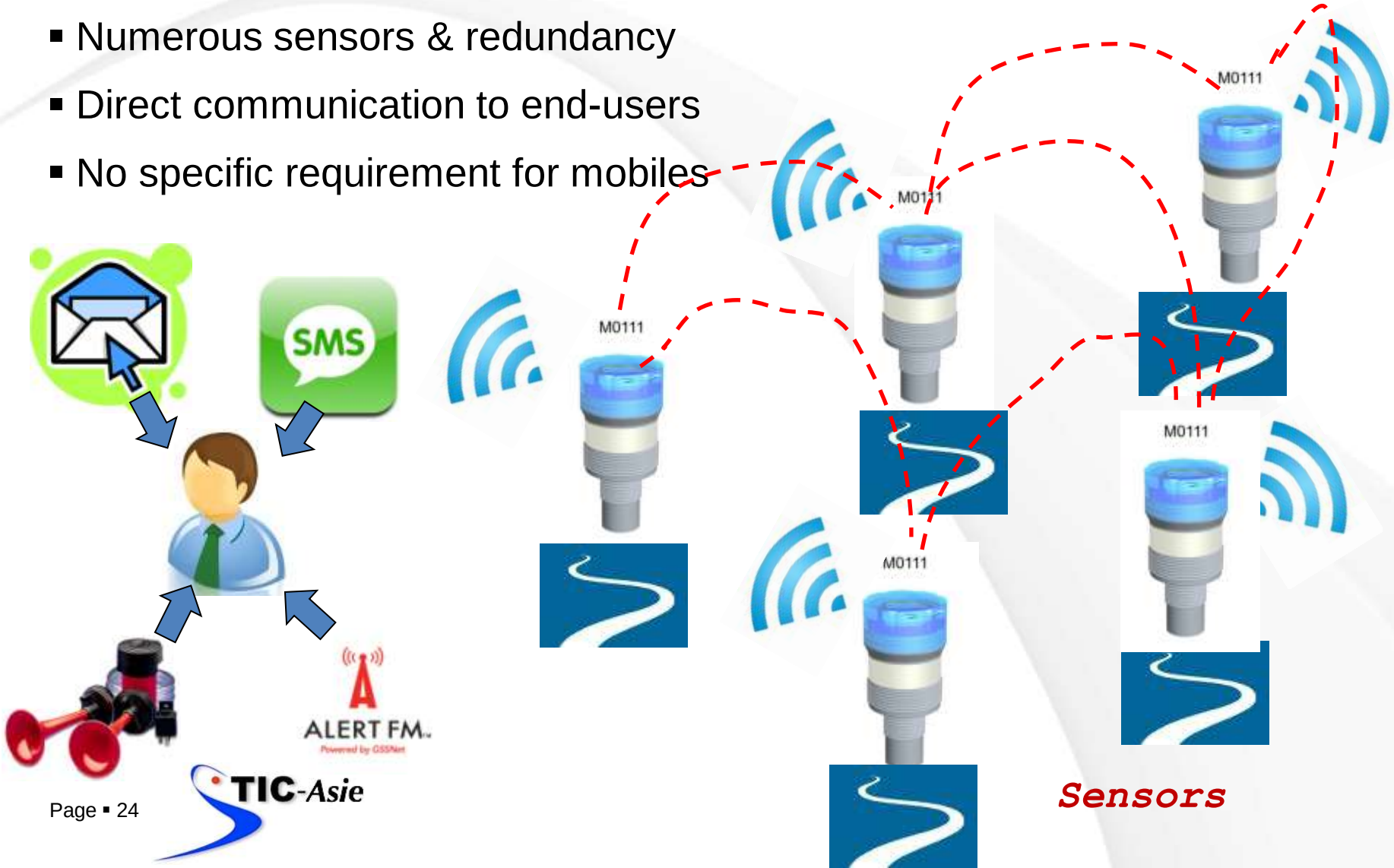
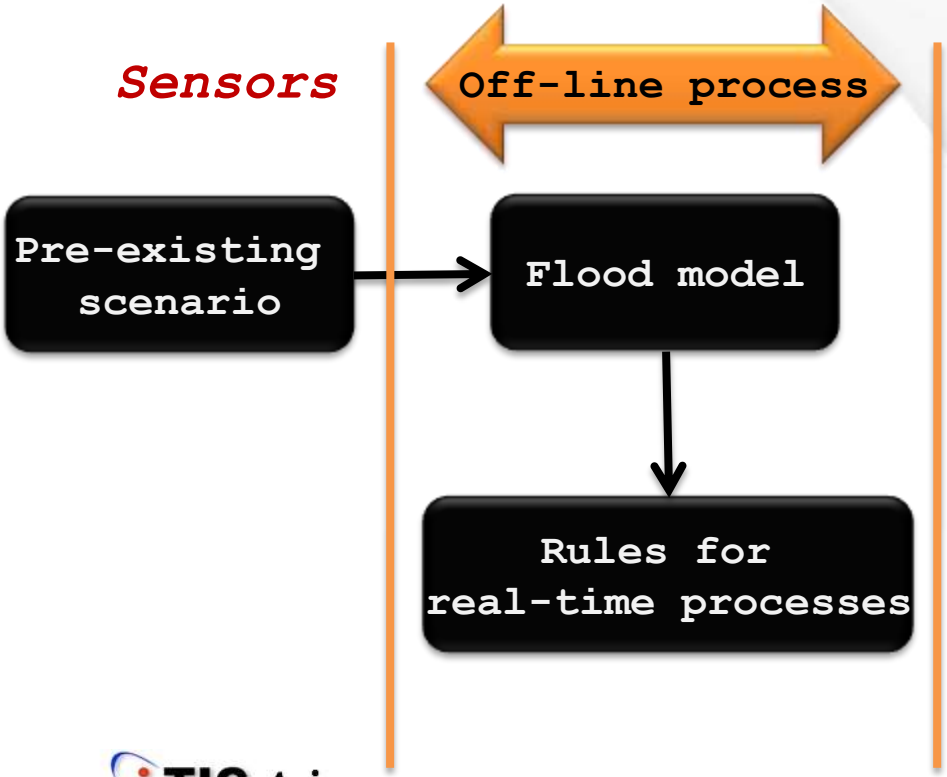
How it can be implemented? [1/3]

- Role of ubiquitous computing in flood warning systems
- Numerous sensors & redundancy
- Direct communication to end-users
- No specific requirement for mobiles



How it can be implemented? [2/3]

- Role of ubiquitous computing in flood warning systems with **offline rules production with pre existing scenarios**.



Conditions	Warning messages

How it can be implemented? [3/3]

- Role of ubiquitous computing in flood warning systems with **real time flood warning processes based on simple rules**.

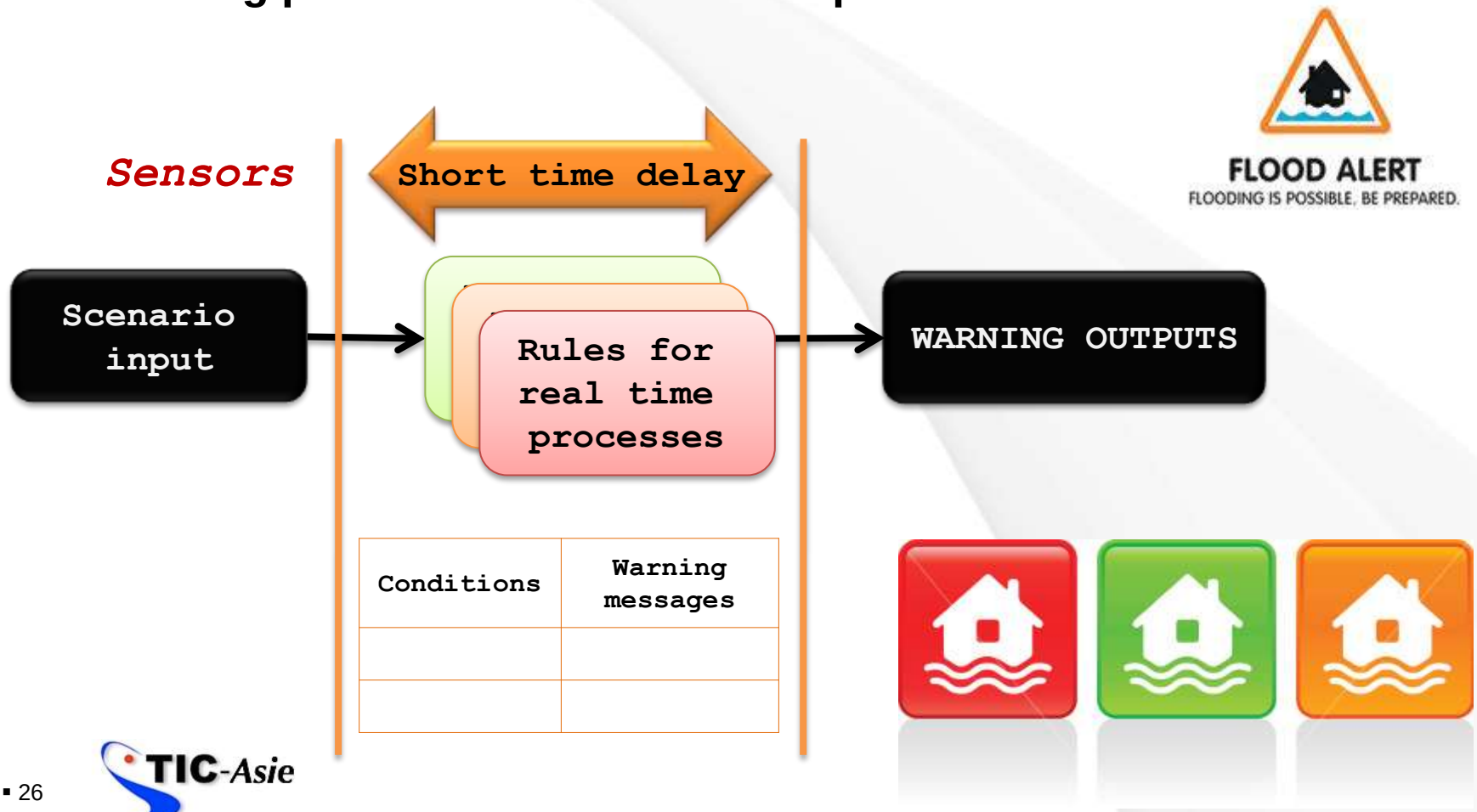
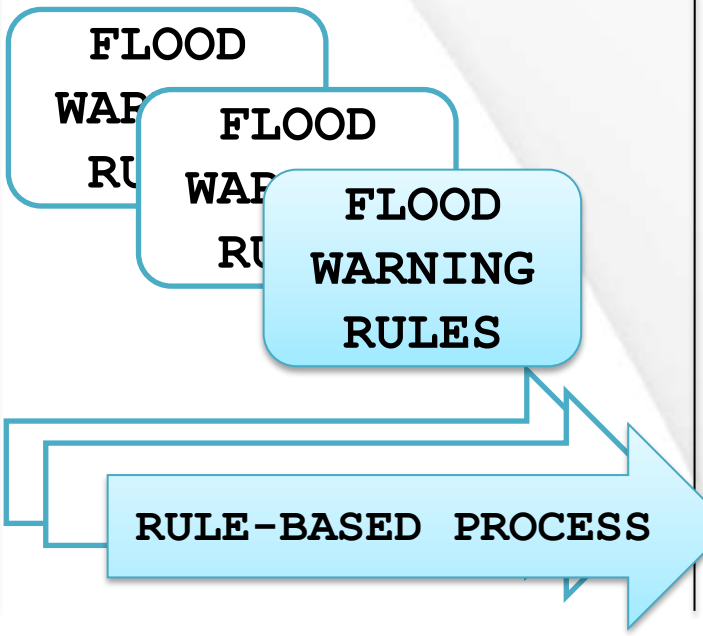


Illustration & application

- With RFID wireless water level sensors

Water level Sensor, Ultrasonic numerical level probe IJINUS

Processes based on independent warning rules



Dedicated and non dedicated Devices and services to warn population

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Illustration & application

- With RFID wireless water level sensors

Water level Sensor, Ultrasonic numerical level probe IJINUS

Processes based on independent warning rules

FLOOD WARNING RULES

RULE-BASED PROCESS

Dedicated and non dedicated Devices and services to warn population

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Illustration - use case [1/3]

For a given area, flood map is representing:

- area;
- possible flood zone;
- flood zone.

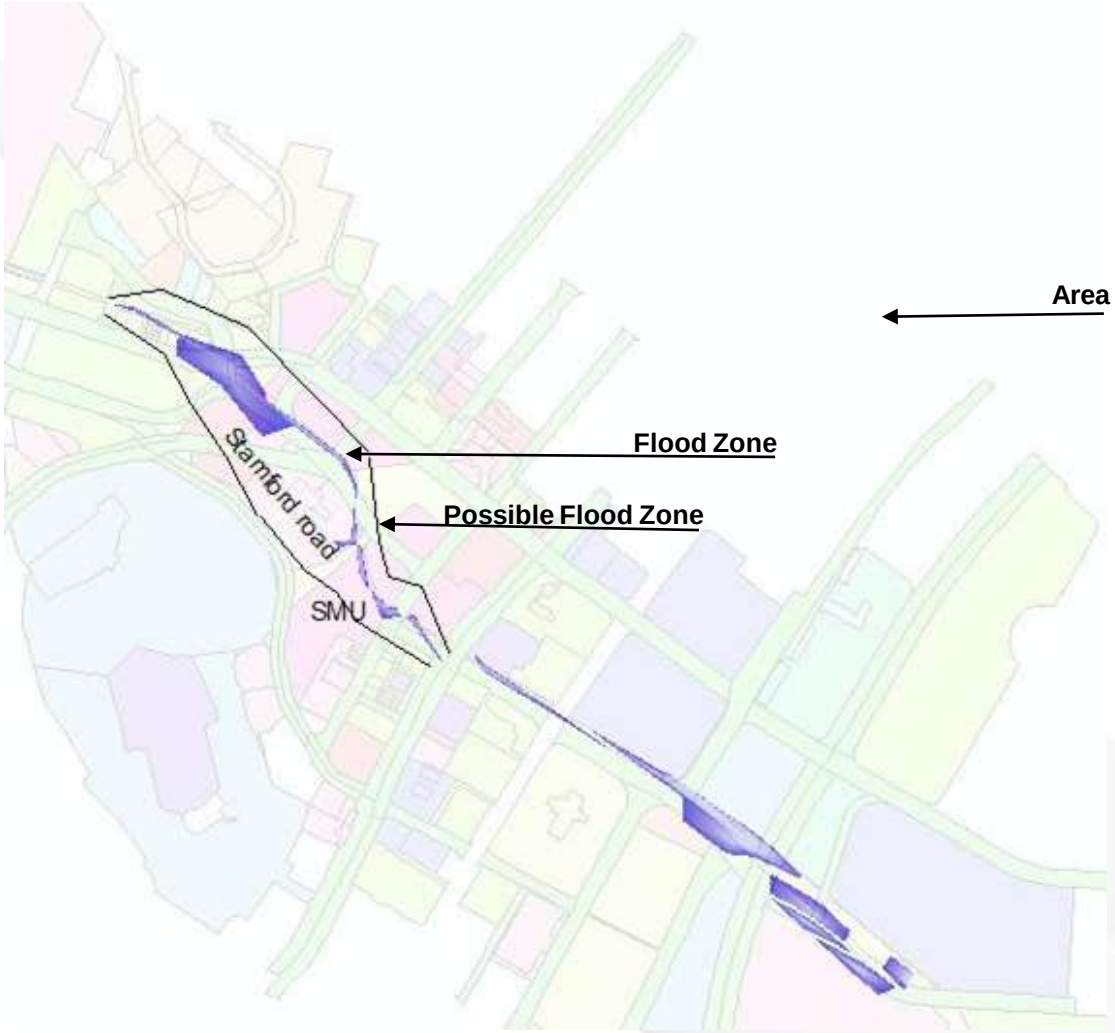

Illustration - use case [2/3]

- Set up alert water levels for different scenarios
- Manage safety measures
- Manage traffic & transport
- Inform about processes

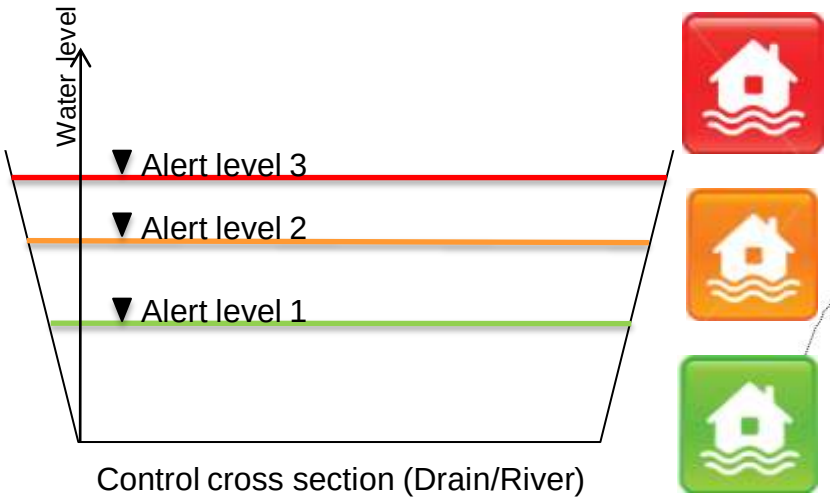

Illustration - use case [3/3]

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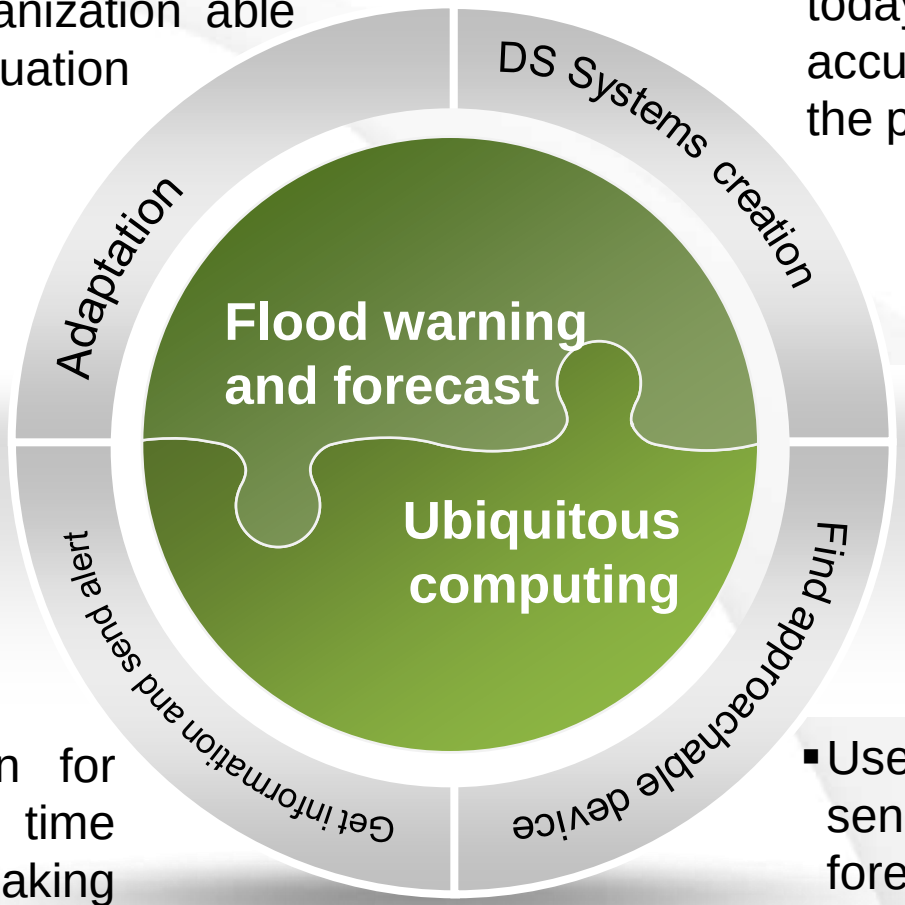
Conclusion and perspectives [1/2]

- Review the Flood Warning Systems & SCADA concepts with ubiquitous approach.
- Ubiquitous approach allows to move from the centralized concept to a distributed environment. Redundancy may be increased with population of communicating sensors (such as RFID)
- Ubiquitous approach & devices may provide a more sustainable architecture than the traditional closed systems.
- Ubiquitous approach could provide an efficient solution for communication to end users
- However, the messages have to be adapted to end users: experts, technicians, citizens according to type of flooding and local conditions.
- Still a need for data collection, recording and monitoring.

Conclusion and perspectives [2/2]

- Societies have to adapt and develop new organization able to assess flood situation

- Modelling tools are able today to provide an accurate representation of the physical processes



- Finding the solution for alert with minimal time spend on decision making processes

- Use different devices to send flood warning or forecasting message to the population

Visit us during the Water Week!

- A demonstrator will be presented during the 2011 Water Week, in Singapore, early July.

RULE-BASED PROCESS

www.ubiflood.eu

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UbiFLOOD project

Ubiquitous computing in flood warning and forecasting systems

Thanks for your attention!

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Planning of Ubiflood

- Where we are now?
  - **Task 1** – Definition and validation of scenarios for new ubiquitous applications

    Done: survey examining different types of urban flooding, existing flood warning and forecasting systems, available devices, communication networks, etc.

  - **Task 2** – Experiments in various environment

  - **Task 3** – Dissemination

    Done: Workshop in South Korea, in September 2010 in association with the ACM international conference Mobility"2010

  - **Task 4** – Mobility

    Mobility between Polytech-Nice and TMSI (November-December 2010)