Challenges in Designing Modern Systems

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25 January 2011, ICONS' 2011 Panel, St. Maarten, The Netherlands Antilles

Challenges in Designing Modern Systems: Sensors-oriented Systems

Prof. Sergey Y. Yurish
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25 January 2011, ICONS' 2011 Panel, St. Maarten, The Netherlands Antilles

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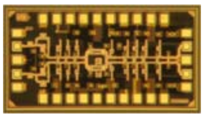

- Technological limitation (below 100 nm)
- Smart sensor systems should be intelligent and intelligent sensor system should be smart
- Next step from MEMS sensors to MEMS sensor systems should be made

Vision

- ☑ System design approach should be used (technological + structural algorithmic design approaches at the same time)
- ☑ New signal domain: frequency (period, time) instead of traditional analog or current
- ☑ New methods of measurements (MDC)
- ☑ New components (UFDC-1, USTI ICs)
- ✖ Trained engineering personnel

Solution

- Road maps corrections: AMA Association for Sensor Technology, IEEE, EPoSS, etc.
- TEMPUS projects
- Advanced engineering training courses
- Other ?

Challenges in Designing Modern Systems
(service-oriented view)

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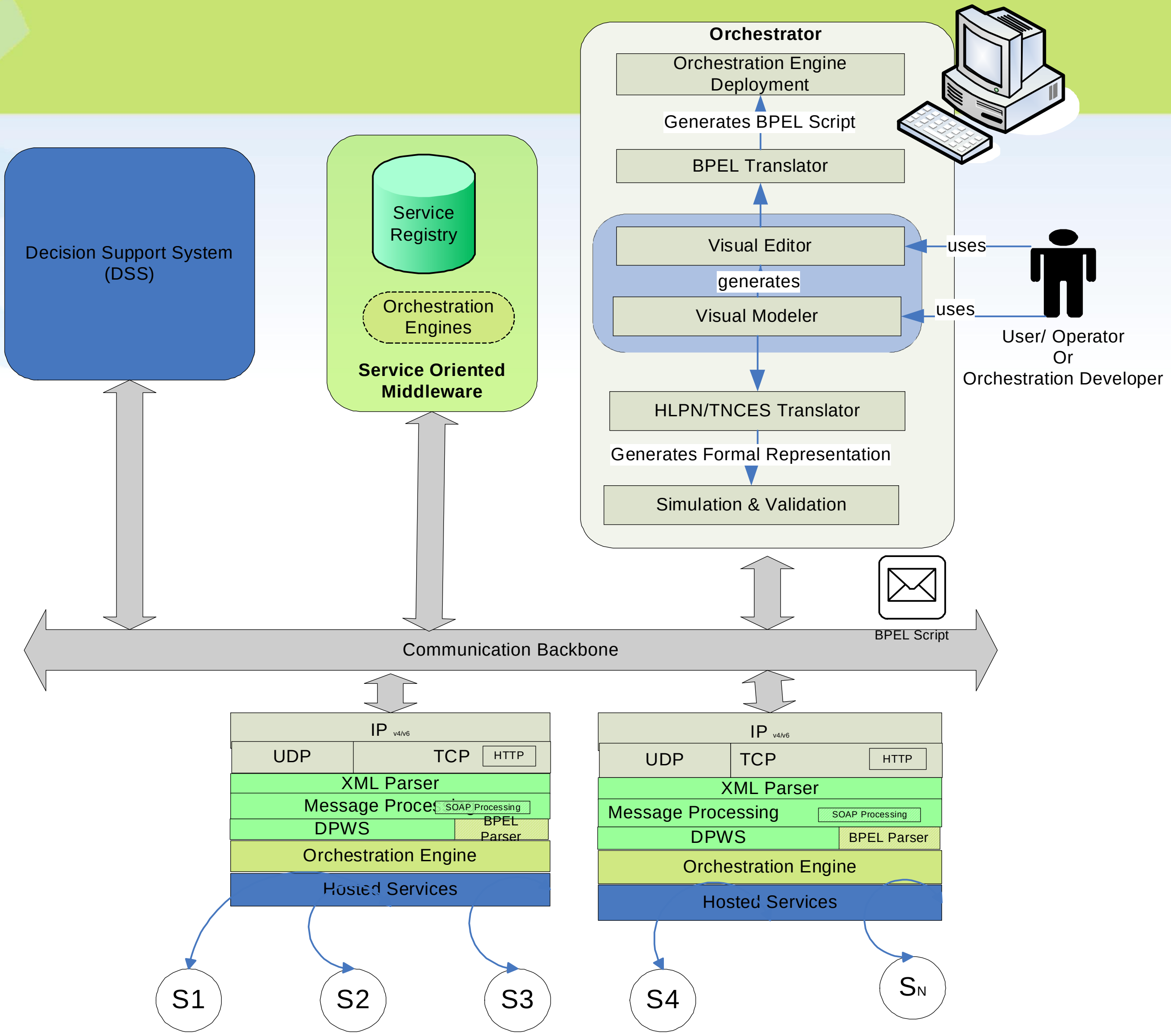
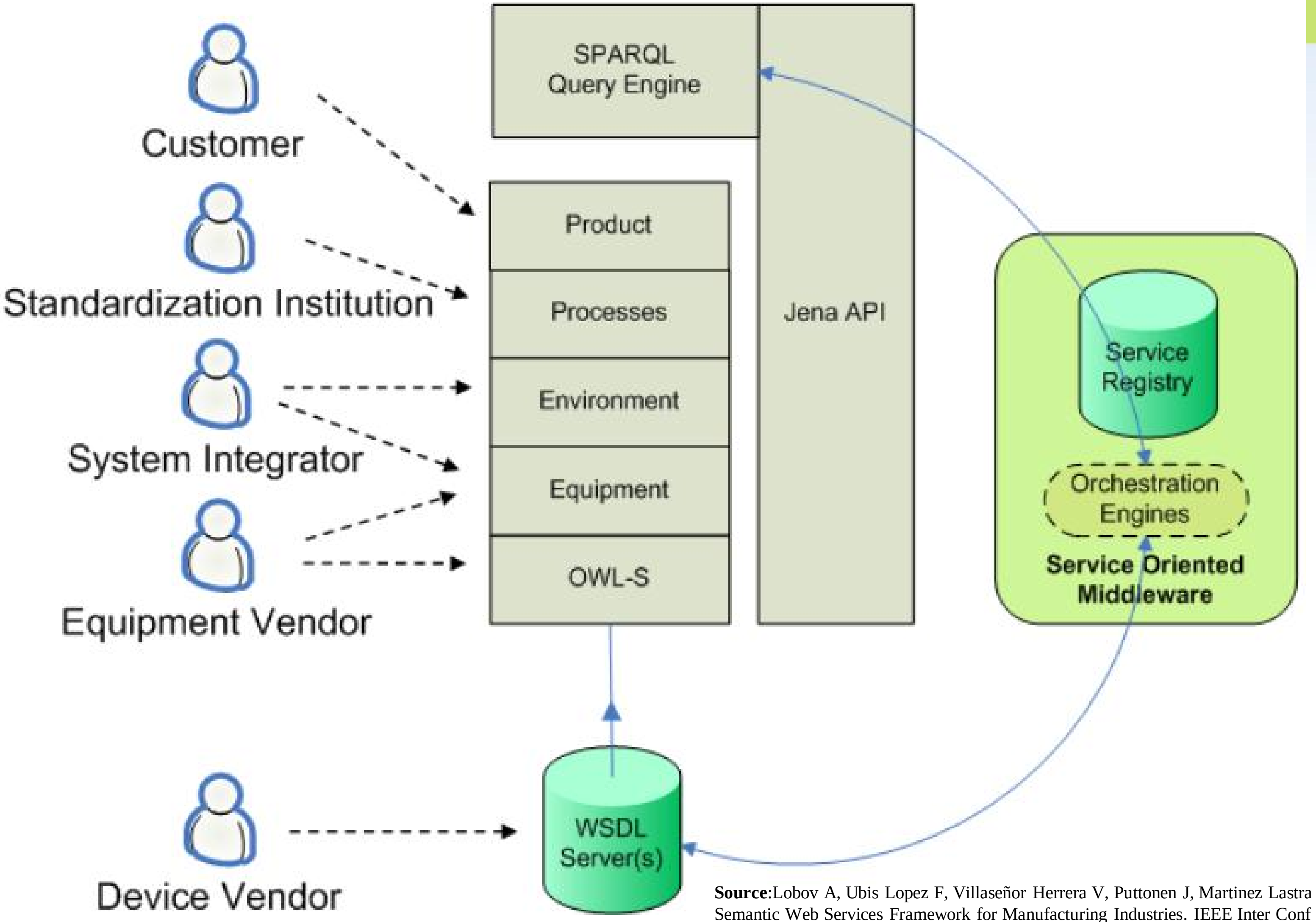


Decision Support System (DSS)
Service Registry
Orchestration Engines
Service Oriented Middleware
Orchestrator
Orchestration Engine Deployment
Generates BPEL Script
BPEL Translator
Visual Editor
generates
Visual Modeler
uses
uses
User/ Operator Or Orchestration Developer
HLPN/TNCES Translator
Generates Formal Representation
Simulation & Validation
BPEL Script
Communication Backbone
IP v4/v6
UDP
TCP
HTTP
XML Parser
Message Processing
SOAP Processing
DPWS
BPEL Parser
Orchestration Engine
Hosted Services
S1
S2
S3
S4
SN

Vision

- *System Development Lifecycle* for service-oriented solutions has to be defined.
- Right level of details has to be selected when defining a service.
- Role shift: “Programmer” → “Knowledge engineer”
- *Value chain* has to be established.

SWS Value chain: Example



Source:Lobov A, Ubis Lopez F, Villaseñor Herrera V, Puttonen J, Martinez Lastra JL (2009) Semantic Web Services Framework for Manufacturing Industries. IEEE Inter Conf on Robotics and Biomimetics (ROBIO-09), 22-25 Feb 2009 Bangkok, Thailand, 2104-2108

Cyber-Physical Systems for Designing Modern Systems

Panel ICONS contribution

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Embedded systems

- **Definition: Embedded systems are information processing systems embedded into enclosing products**
- **Embedded software is software integrated with physical processes (technical problem is managing time and concurrency in computational systems)**

Cyber-physical systems

- **Definition: Cyber-Physical Systems (CPS) are integrations of computation and physical processes**

Cyber-physical systems design

The integration of physical systems and processes with networked computing has led to the emergence of a new generation of engineered systems: Cyber-Physical Systems (CPS)

- CPS use computations and communication deeply embedded in and interacting with physical processes to add new capabilities to physical systems
- Embedded computers allow designers to add capabilities to physical systems that they could not feasibly add in any other way
- By merging computing and communication with physical processes and mediating the way we interact with the physical world, cyber-physical systems bring many benefits: they make systems safer and more efficient, they reduce the cost of building and operating these systems, and they allow individual machines to work together to form complex systems that provide new capabilities

CPS properties

CPS domain paradigm:

application requirements (time constraints defined by physical processes), and

implementation aspects (computation and communication capacity constraints)

- Functionality = services delivery in the form and time fitting requirement specifications
- Dependability = property of a system that allows reliance to be justifiably placed on the service it delivers

Dependability measures:

- Availability = ability to deliver shared service under given conditions for a given time (e.g. elimination of denial-of-service vulnerabilities)
- Security = ability to deliver service under given conditions without unauthorized disclosure or alteration of sensitive information
- Safety = ability to deliver service under given conditions with no catastrophic affects

CPS networking

= hierarchically interconnected networks: Internet, local area wired and wireless networks, and wireless sensor networks.

Embedded systems and their components can be attached to **Ethernet with TCP/IP** protocol stack but also through various wired Fieldbuses or wireless technologies such as ZigBee or Bluetooth

Sensor networks bring an important pattern with single base station connected to a wired network on one side and wirelessly to smart sensors on the other side

Migrating from Mobile RFID to NFC

NS 2011, St.Maartens

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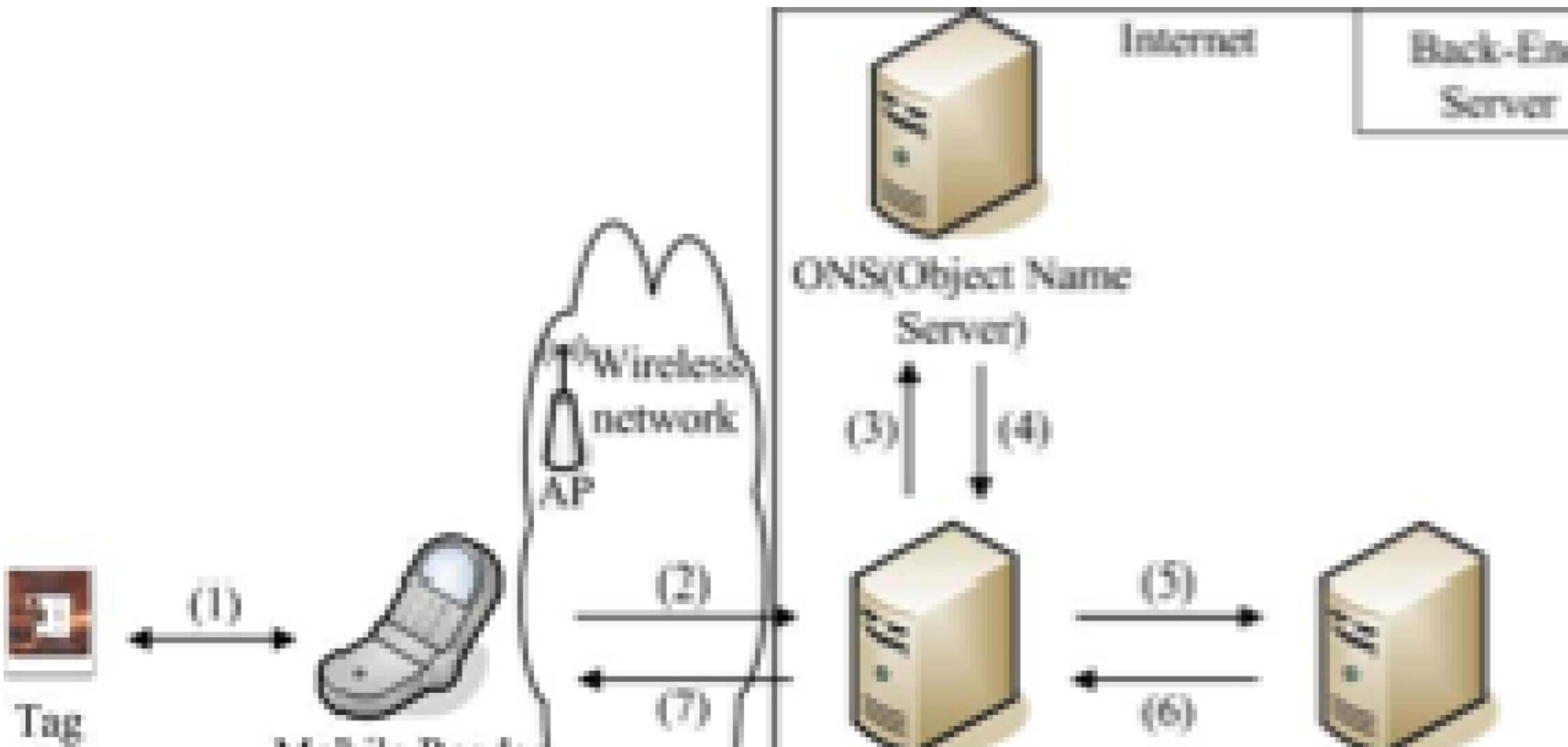
obile RFID

obile Radio-Frequency Identification
MRFID)



NFC

ear field communication

- combines the interface of a smartcard and a reader into a single device.
- compatible with existing contactless infrastructure already in use for public transportation and payment.
- primarily aimed at usage in mobile phones

oal

- Uses NFC framework to replace Mobile RFI infrastructure
- Design NFC Payment protocols, includes:
  - Authentication protocol
  - Authorization protocol
  - Accounting protocol

ICONS Panel Discussion: Challenges in Designing Modern Systems

Validation of Traffic Flow Models

6th International Conference on Systems
ICONS 2011
St. Maarten, The Netherlands Antilles

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2011-01-25

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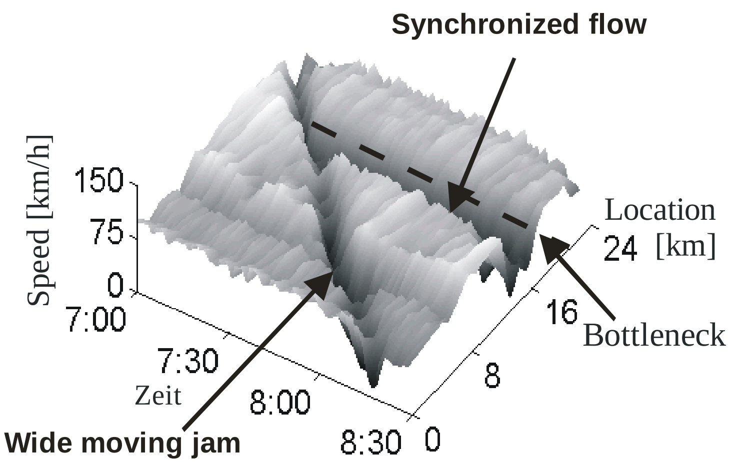
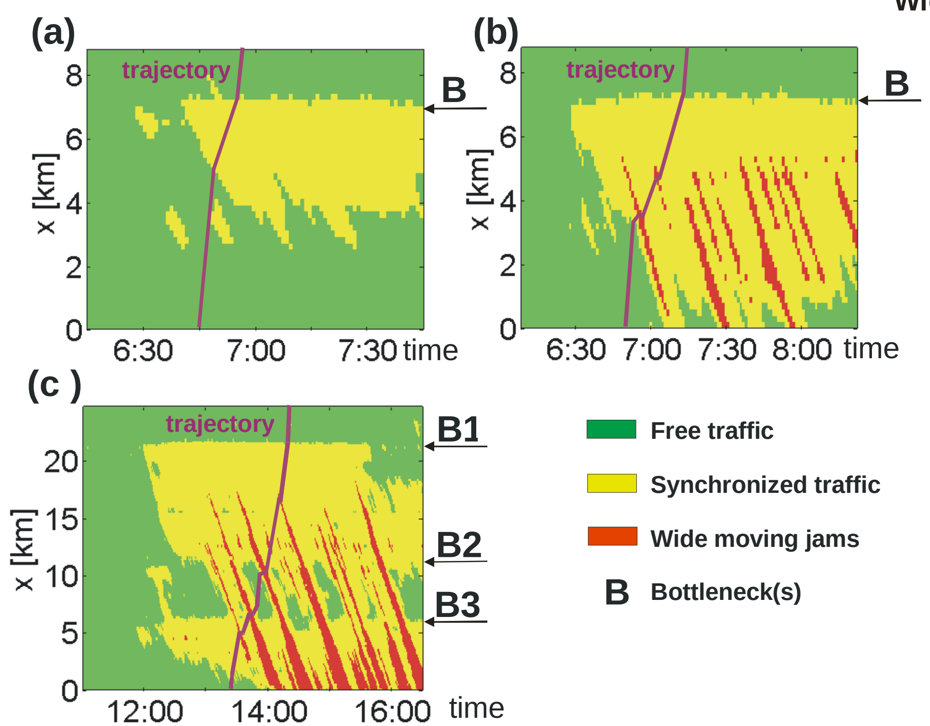
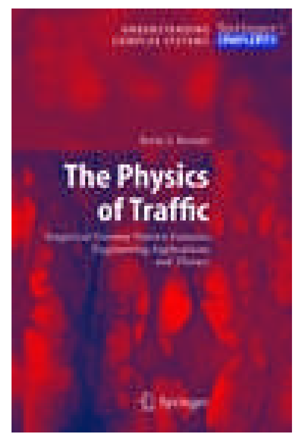
Background: Kerner‘s Three Phase Traffic Theory

- Three traffic phases – F, S and J
  - F – Free Flow
  - S – Synchronized Flow
  - J – Wide Moving Jam
- Spatio temporal traffic patterns
  - SP – Synchronized pattern
  - GP – General pattern
  - EP – Expanded pattern

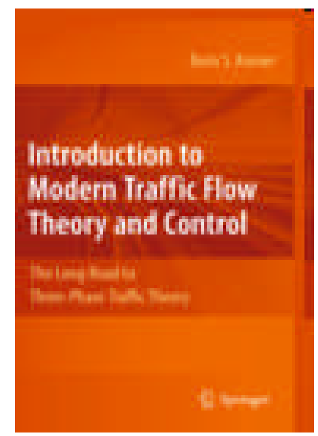
Two Phases in Congested Traffic







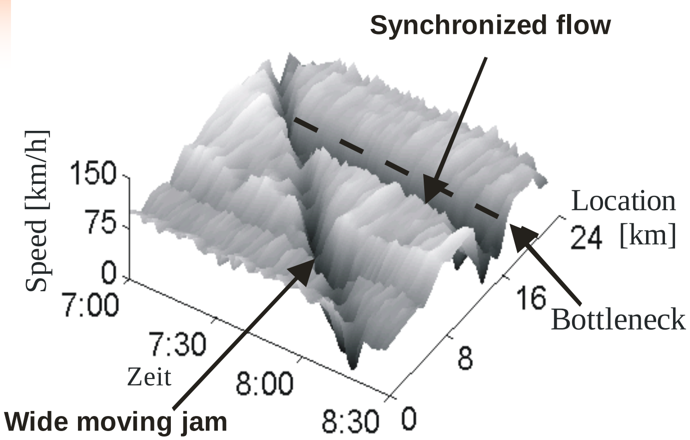
Kerner, The Physics of Traffic, Springer; Berlin, 2004.



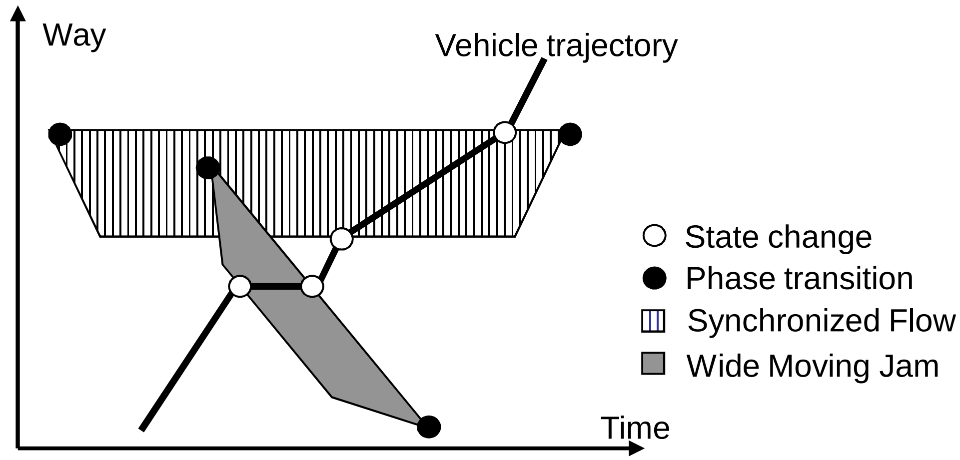
Kerner, Introduction to Modern Traffic Flow Theory and Control, Springer; Berlin, 2009.

Status: Incomplete Information About Traffic Reality

Two Phases in Congested Traffic



a) Collective averaged measurements

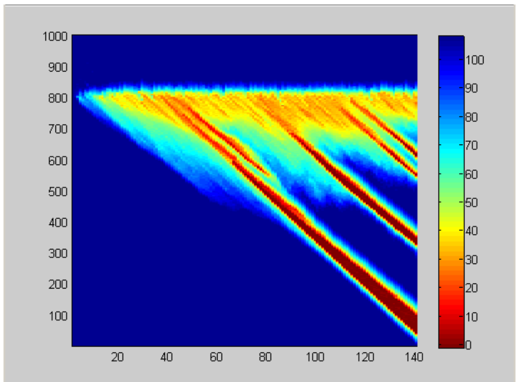


b) Individual vehicle trajectory measurements

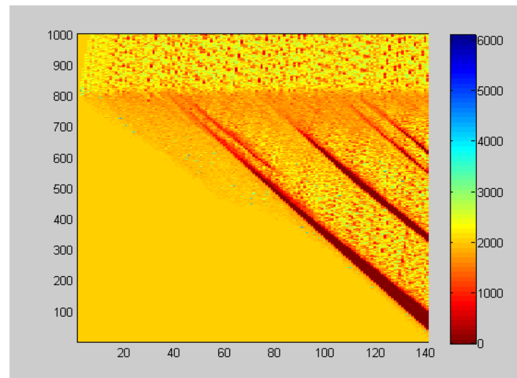
- Knowledge about traffic reality ("Ground-Truth") is incomplete.
- Collective traffic measurements (a) are available. They do NOT describe individual vehicles.
- Individual vehicle trajectories are available. Penetration rates of < 1% owned by private companies.
- Individual vehicle trajectories (b) are required:
  - Science: Validation and verification of traffic flow theories and models.
  - Industry: Development of new traffic engineering applications. Using individual vehicles as mobile sensors.

Vision: Combining Simulations and Better Data Acquisition

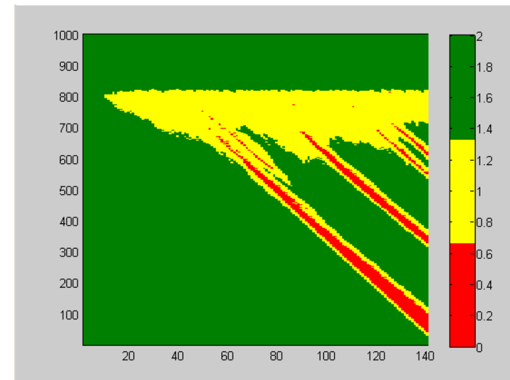
1st Step: Using traffic flow models for the simulation of vehicle trajectories. Challenge: Validation of models used for the simulations.



Speed



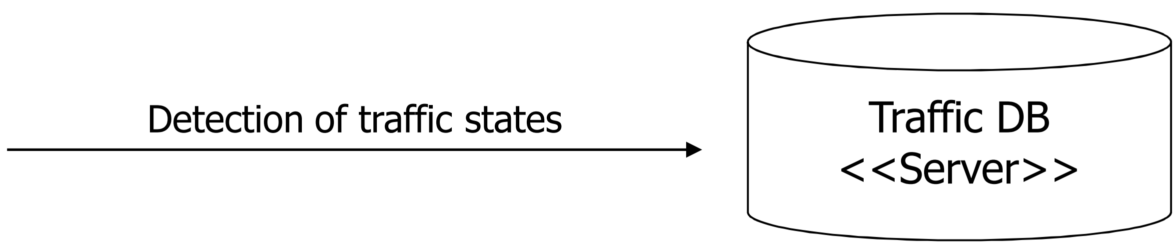
Flow



Traffic State

Ground-Truth output of Kerner-Klenov microscopic traffic model

2nd Step: Better data acquisition using Smartphones and PNDs. Challenge: Business model, privacy, security.



Combined results: More complete real world coverage, validated simulations and more accurate traffic flow theories.