In-Network Management: A new Paradigm for Managing the Future Internet

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Internet Evolution and Requirements

- **Internet Trends**
  - fast growth of # and diversity of network nodes (Mobile handsets, PANs, WSNs,....)
  - moving from pure data (packet) service to universal multiservice network
  - Incorporating completely new scenarios (e.g. Vehicular Networks)

- **Problems with today's Internet Structure**
  - Internet was not designed for mobility, security, QoS,...
  - **No separation of mechanism and policy (hardwired strategies)**
  - **Rapid network growth makes configuration and operation (management) more and more complicated**
  - With the advent of low power mass devices (e.g. sensors) there is a definite need for simpler, more autonomous network configuration and operation
  - Duplicate meaning of IP addresses as location and host ID complicates mobility management and domain management/security

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Problems for Network and Service Management

| System Architect (Network or Service) | Management System Architect (for Network or Service) |
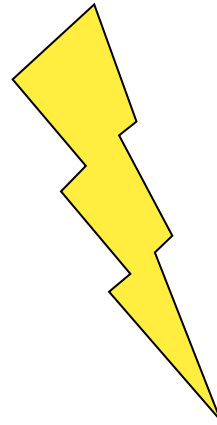
- Different System Understanding
- Different Language to Describe a System
- Different People designing
- System Design Compromises with Architectural flaws
    - Makes it difficult to manage
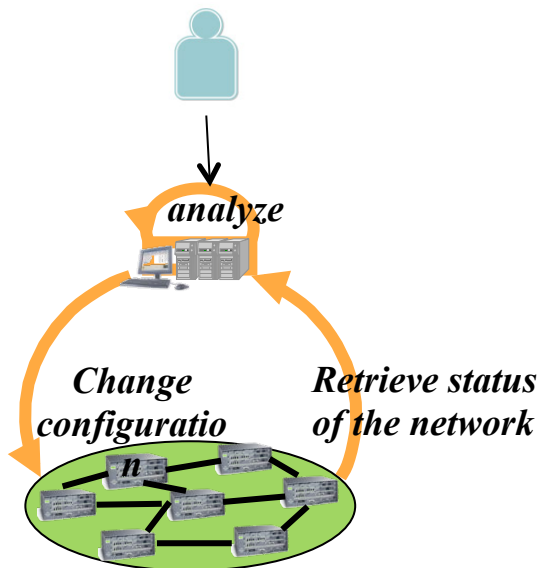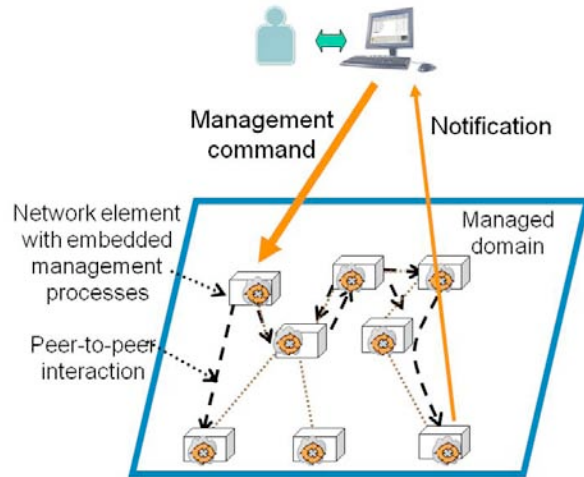   - Difficult to find machine usable model of a system

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Management is Still Considered an "Add-On" or Afterthought

- The typical technology development process has network management capabilities at the very end
  - often the last step before final deployment
    - needs to be done in a rush
    - only some functionality is possible to be managed through systems accessing a standardized management interface
      - All feature of a system are manageable through a CLI/config file
  - it gets **"*attached*"** to the technology
    - needs to deal with architectural problems

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In-Network Management a new paradigm?

Management command

Notification

Network element with embedded management processes

Managed domain

Peer-to-peer interaction

analyze

Change configuration

Retrieve status of the network

1. **Built-in at design time**

2. Monitoring and optimization functions as **embedded capabilities** of network and service components

3. Rather **co-design** than retro-fit

→ Natural support of self-management with reduced integration costs and shortened service deployment cycles

→ Part of System Design process

→ For a basic example, see IPv6 built-in auto-configuration
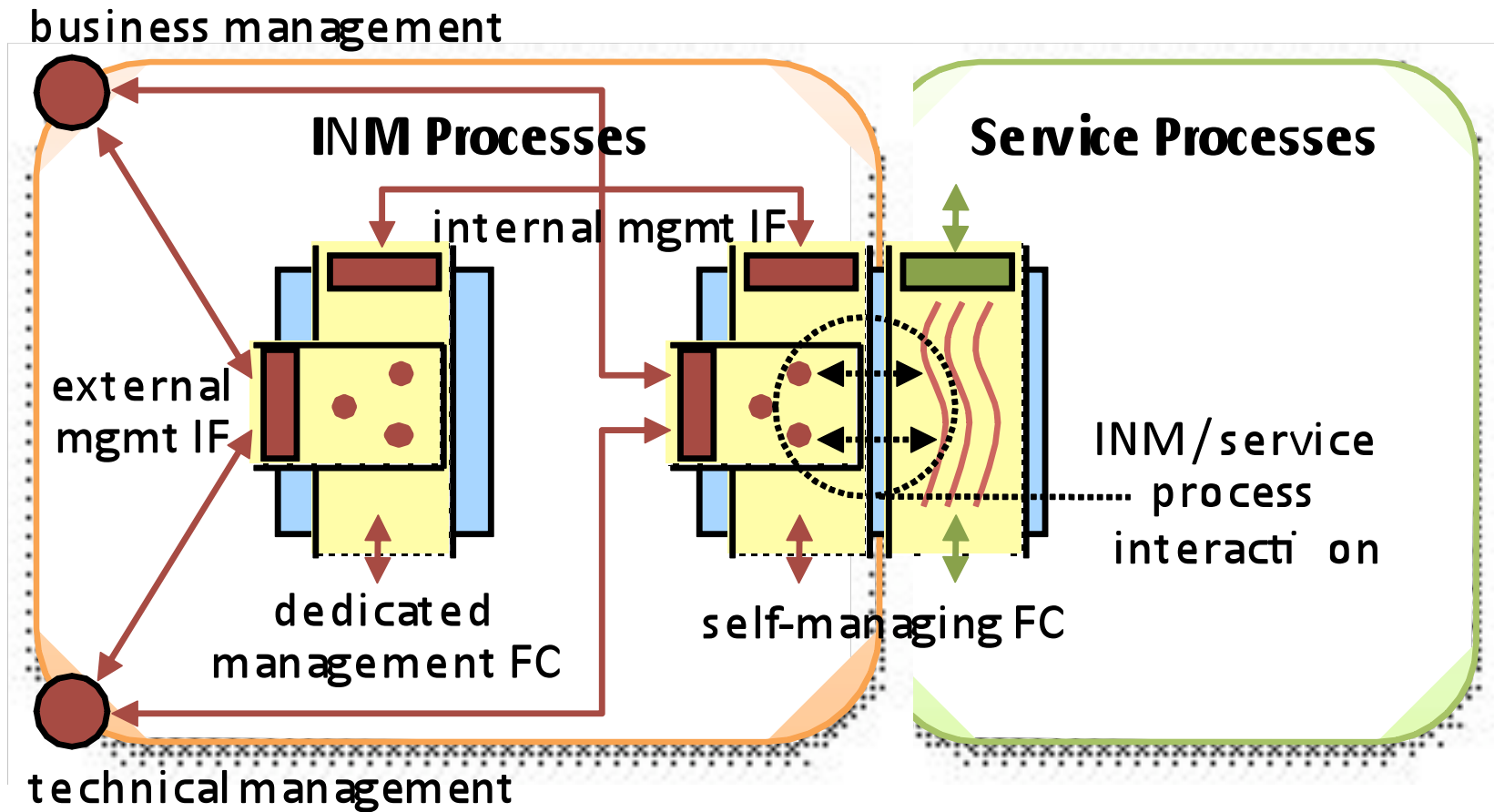
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INM Evolution

- One size doesn't fit all
- Several degrees of freedom to design management functionality
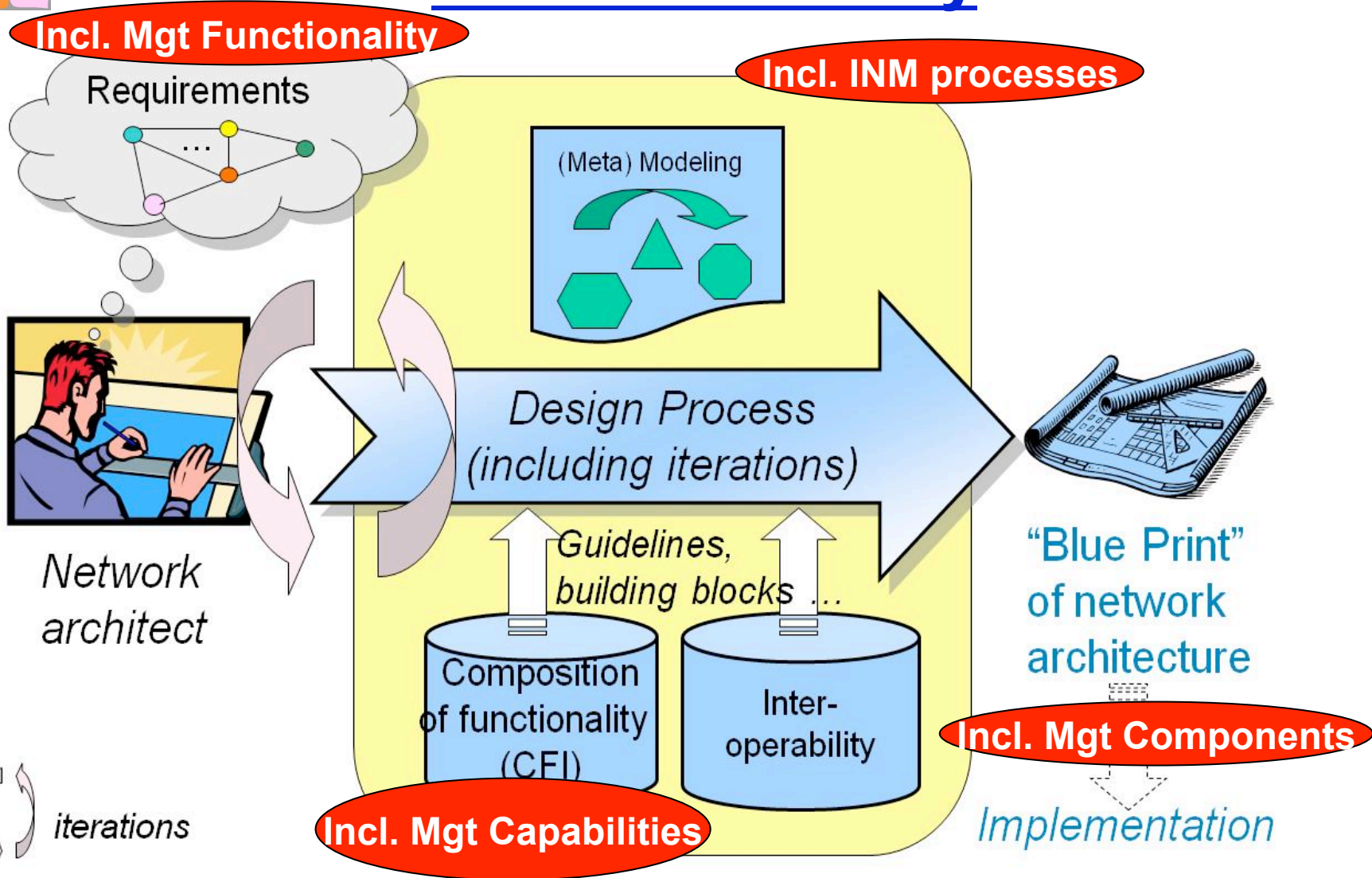- Allows for evolutionary approach and migration of parts

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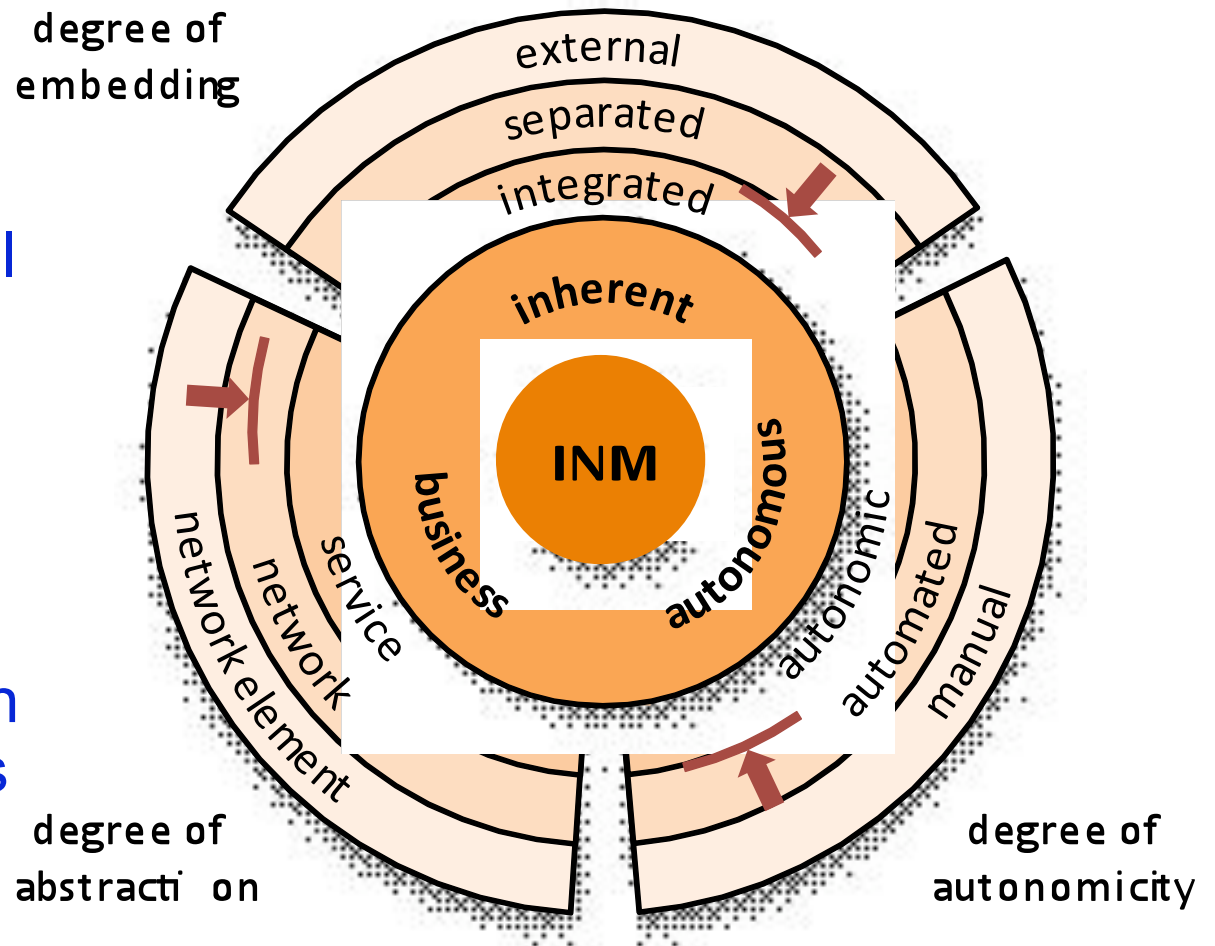
In-Network Management Services and Processes

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Challenges

- What are the management specific base components to be used to design built-in management
  - Management patterns
  - Software Engineering methods
- How do data handling
  - Modeling, distribution, more decentralized
- How to bootstrap the management plane
  - Find management capabilities
  - Connect management capabilities, which belong together
- How does the integration into overall management processes work
  - Specification of rules, policies, goals
- Interaction with legacy

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<u>Summary</u>

In-Network Management leverages on four aspects:

1. A **new design principles** for embedded management capabilities
2. Enables **Self-Management** from ground-up
3. A **systematic study** of distributed algorithms for self-*
4. Useful for service, systems, and network management

Benefits:

- Easy manageability of the Future Internet
- Reliability of network under different conditions
- New design approach to tackle costs of management operations

Only new **Future Internet Design** allows for INM at design time

Overall INM aims at a **cost-effective, distributed, built-in management infrastructure for the Future Internet!**

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