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**Rethinking Wireless Network
Design, Management and
Operation**

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Challenges in Wireless Networks

- **A dramatic increase in demand for radio spectrum in future**
 - Data transferred in 2009 was nearly ten times as large as in 2007
 - The number of NEs will grow fast (Gupta&Kumar'00)
 - A huge number of wireless devices will become integrated into physical objects and linked through wireless networks (**Internet of things, M2M ...**)
- **Low-complexity, autonomous, architecture-less wireless networks**
- **Wireless network management faces unprecedented challenges**
 - Release dependence from manual control, adapt to the mandate for autonomous management, realize resource-efficient feedback control...
- **Efficient wireless network operation faces fundamental challenges**
 - gigantic amount of (sporadically) generated data, limitations on underlying spectrum and other resources, obstacle of interference regimes, energy consumption, reliability, privacy and trust ...

Paradigm shift

- **Current network management methods will be inadequate to cope with the growth of autonomous (NE). They must account for**
 - Unreliable network state information of limited accuracy
 - Possibly conflicting and abstractly defined objectives
- **The development and commercialization of many types of wireless networks have been stunted by the lack of a theoretical framework for analyzing and designing MANETs**
 - Current information theory ignores bursty traffic, finite flows/sessions, queuing delay and a considerable amount of overhead.
 - Wireless networking theory ignores the interference structure and does not fully utilize to the broadcast property of wireless networks.
- **Paradigm shift in network design and management/operation is needed to prevent a slowdown in network development.**

Wireless Network Management

- **Create awareness at the level of autonomic network elements:**
 - Learn and reason through sensing, observing, data exchange, probing, and information extraction based on inaccurate, unreliable data.
 - Improve accuracy through intelligent feedback collection, efficient consensus algorithms and sophisticated information fusion techniques
- **Incorporate awareness into the network management control loop:**
 - Cope with partial, inaccurate or delayed state information
 - Overcome the obstacle of conflicting network management objectives
- **Merge computation and wireless communication: exploit the broadcast property**

Wireless Network Control/Operation

- **Envisioned wireless networks mandate epistemic approaches to wireless network control, state acquisition and prediction of operating points.**
- **Fresh ideas and tools, and a think-outside-the-box approach.**
- **A novel, clean-slate approach is needed:**
 - Combine game theory, control theory and information theory.
 - Encompass the notion of information.
 - Bridge the gap between content/application semantics and the communication infrastructure/operating protocols.
 - Understand cooperation and the full range of behavioral profiles.
 - Exploit interference structure and the broadcast property.
 - Embrace context awareness and feedback control.
 - Use efficient consensus algorithms and sophisticated information fusion techniques, merge computation and communication
 - Capture the role of side information.
 - ...

**„It is dangerous
to put limits on wireless”**

**G. Marconi
Nobel prize winner 1909**