Application BASTRI

Fiches Equipes

EVA (SR0694LR)

Wireless Networking for Evolving & Adaptive Applications
HIPERCOM2 (SR0545VR) ⬜ EVA ⬜ EVA (SR0741KR)

Statut: Terminée

Responsable : Paul Mühlethaler

Mots-clés de "A - Thèmes de recherche en Sciences du numérique - 2024" : *Aucun mot-clé.*

Mots-clés de "B - Autres sciences et domaines d'application - 2024" : *Aucun mot-clé.*

Domaine : Réseaux, systèmes et services, calcul distribué
Thème : Réseaux et télécommunications

Période : 01/04/2015 -> 30/04/2016
Dates d'évaluation :

Etablissement(s) de rattachement : <sans>
Laboratoire(s) partenaire(s) : <sans UMR>

CRI : Centre Inria de Paris
Localisation : Rocquencourt
Code structure Inria : 021139-0

Numéro RNSR : 201521336F
N° de structure Inria: SR0694LR

Présentation

EVA will tackle challenges related to providing efficient communication in wireless networks and, more generally, in all networks that are not already organized when set up, and consequently need to
evolve and spontaneously and a match between application requirements and the environment.
These networks can use opportunistic and/or collaborative communication schemes.
They can evolve through optimization and self-learning techniques. Every effort will be
made to ensure that the results provided by EVA will have the greatest possible impact on
standardization.
The miniaturization and ubiquitous nature of computing devices has opened the way to
the deployment of a new generation of wireless (sensor) networks. These networks will be
central to the work in EVA, as EVA will focus on such crucial issues as power conservation,
connectivity, determinism1 , reliability and latency. Wireless sensor network (WSN)
deployments will also be a new key subject, especially for emergency situations (e.g. after a
disaster). Industrial process automation and environmental monitoring will be considered in
greater depth.

Axes de recherche

EVA's research directions are the following:

I Wireless Access

EVA will pursue modeling tasks to compare access protocols, including multi-carrier access,
adaptive CSMA (particularly in VANETs), as well as directional and multiple antennas.
There is a strong need for determinism in industrial networks. The EVA team will focus particularly
on scheduled medium access in the context of deterministic industrial networks; this will involve optimizing the joint time slot and channel assignment. Both centralized

En savoir plus

- Site de l'équipe
- Site sur inria.fr
- Derniers Rapports d'Activité : 2016 , 2017 , 2018 , 2019 , 2020 , 2021

Documents sur la structure

- Intranet
- Privés

Décisions

- 10903 (17/04/2015) : création

Localisation

- **Adresse postale :** *Non renseignée*
- **Coordonnées GPS :** 48.83703, 2.103342

and distributed approaches will be considered, and the EVA team will determine their limits
in terms of reliability, latency and throughput. Furthermore, adaptivity to application or
environment changes will be taken into account.

The challenge is to design scheduling algorithms that are close to optimal without generating
a large amount of traffic to inform the nodes about their schedules. Furthermore, these algorithms must also be able to adapt to changes in topologies, traffic and application
requirements. In VANETs, a major challenge is to cope with varying densities of vehicles.
We will use simulations and mathematical models such as scheduling theory, stochastic geometry,
etc. to determine bounds. The expected results are new algorithms and protocols.

II Energy-Efficiency and Determinism

Reducing the energy consumption of low-power wireless devices remains a challenging
task. The overall energy budget of a system can be reduced by using less power-hungry chips,
and significant research is being done in that direction. Nevertheless, power consumption is
mostly in uenced by the algorithms and protocols used in low-power wireless devices, since
they in uence the duty-cycle of the radio.
EVA will search for energy-efficient mechanisms in low-power wireless networks. One new
requirement concerns the ability to predict energy consumption with a high degree of accuracy.
Scheduled communication, such as the one used in the IEEE 802.15.4e TSCH standard,
and by IETF 6TiSCH, allows for a very accurate prediction of the energy consumption of a
chip. Power conservation will be a key issue in EVA.

III Network Deployment

Since sensor networks are very often built to monitor geographical areas, sensor deployment
is a key issue. The deployment of the network must ensure full/partial, permanent/
intermittent coverage and connectivity. This technical issue leads to geometrical
problems which are unusual in the networking domain.
We can identify two scenarios. In the first one, sensors are deployed over a given area to
guarantee full coverage and connectivity, while minimizing the number of sensor nodes. In
the second one, a network is re-deployed to improve its performance, possibly by increasing
the number of points of interest covered, and by ensuring connectivity. EVA will investigate
these two scenarios, as well as centralized and distributed approaches. The work starts with
simple 2D models and will be enriched to take into account more realistic environment:
obstacles, walls, 3D, fading.

IV Data Gathering and Dissemination

In EVA, we will focus on raw data convergecast in multichannel low-power wireless networks.
In this context, we are interested in centralized/distributed algorithms that jointly
optimize the channel and time slot assignment used in a data gathering frame. The limits in
terms of reliability, latency and bandwidth will be evaluated. Adaptivity to additional traffic
demands will be improved. Already in the HiPERCOM2 team, we generalized the lower
bound on the number of slots required by data gathering applications, taking into account
multiple interfaces of the sink and the number of channels available [IPCC2012].
The challenge here is to design algorithms and provide bounds on the performances achievable
by multichannel communication for data gathering applications. We will use analytical
and simulation models. The expected results are accurate bounds on data gathering durations
and delivery time to the sink. We also expect to design new algorithms and protocols.

V Security Trade-off in Constrained Wireless Networks

Ensuring security is a sine qua non condition for the widespread acceptance and

adoption
of the IoT, in particular in industrial and military applications. While the Public-Key
Infrastructure (PKI) approach is ubiquitous on the traditional Internet, constraints in terms
of embedded memory, communication bandwidth and computational power make translating
PKI to constrained networks non-trivial.
Two related standardization working groups were created in 2013 to address this issue.
DICE is defining a DTLS profile that is suitable for IoT applications, using the CoAP protocol.
ACE is standardizing authentication and authorization mechanisms for constrained
environments.

The issue is to find the best trade-off between a communication and computation overhead
compatible with the limited capacity of sensor nodes and the level of protection required by
the application.
The main challenge is to design security architecture in constrained wireless networks
(memory, energy, communication bandwidth, etc.). The tools used will be models and simulations.
The expected results are new security architectures.

Relations industrielles et internationales

Industrial partnership

The EVA team will pursue collaboration opportunities with industrial partners to secure
funding for graduate students (Master and PhD levels) and research engineers. Examples are
EDF, CNES, Alcatel-Lucent, Vedecom (Paul Mühlethaler is supervising a PhD on the use
of Vehicle to Vehicle communication to improve road safety) , Thales (collaboration foreseen
on directional antennas).

Interantional collaborations

EVA will pursue the collaboration of the HiPERCOM2 team with: the University
of Berkeley (USA), Catania University (Italy), CRC (Canada), ENSI (Tunisia), ENSIAS
(Morocco), Macquarie University (Australia), UCLA (USA).
Moreover, AWSN (\Auto-adaptivity in Wireless Sensor Networks") is an Euromediterranean
project between two Southern countries (Tunisia through ENSI, Morocco through ENSIAS)
and two Northern countries (Italy through the University of Catania, France through
Inria). The AWSN project focuses on different techniques to make WSNs auto-adaptive with
regard to various changes in the environment/application, while meeting the application
requirements.
The EVA team has set up an associate team with Prof. Glaser's group (University of

25

Berkeley) and Prof. Kerkez's group (University of Michigan, Ann Arbor) for 2015-2017. Prof.
Glaser's and Prof. Kerkez's teams are revolutionizing environmental monitoring by using low
power wireless TSCH networks to produce continuous environmental data accessible in real
time. They are successfully deploying these networks to study mountain hydrology, observe
water quality in urban watersheds, and build intelligent urban stormwater grids. The
REALMS associate team will conduct research across the environmental engineering and
networking research domains. Its 3-year goal is to develop easy-to-use real-world network
monitoring solutions to provide real-time data for environmental and urban applications.
This goal leads to the following objectives: building a long-term large-scale public connectivity
dataset of the networks deployed; using that dataset to model TSCH networks; and
building an ecosystem of tools around this technology.
Furthermore, the EVA team is answering European project