Advances in Forestry Control & Automation Systems in Europe

"More than the Sum of its Parts?" – Enhancing Optimisation for the Forest-based Value chains by Integrating Process Specific Optimisation Solutions

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Introduction

FOCUS Project Overview I

- **FOCUS**: Advances in **Fo**restry **C**ontrol and A**u**tomation **S**ystems in Europe
- SME-targeted collaborative research project funded by European Community (7th Framework Programme) with a duration of **30 months**.
- **Objectives**:
  - Advancing forestry control and automation
  - Combination of control, monitoring and planning
  - Making use of advanced sensor technologies

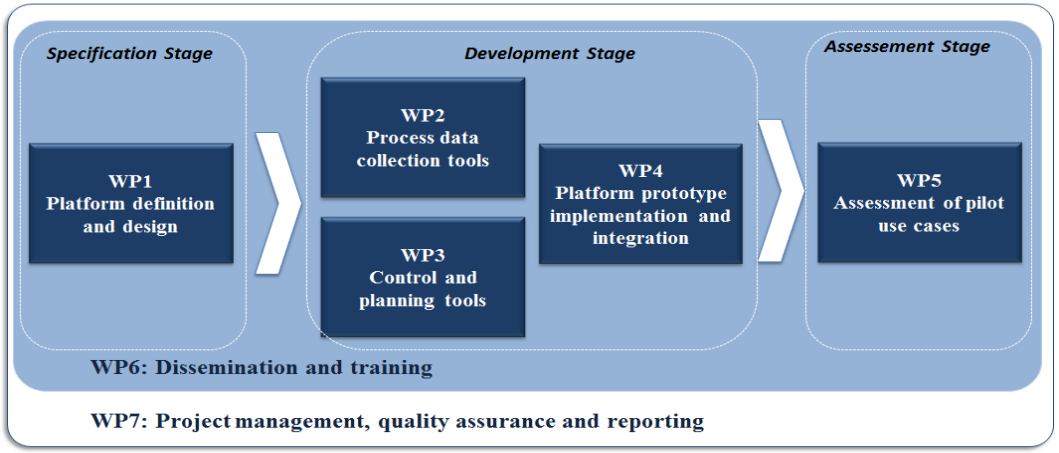
→ to support the management of the operations of the forest-based supply chain

- **Consortium:** 12 partners, 6 are SMEs (developers & users of technologies in forestry)

Introduction

FOCUS Project Overview II

- **FOCUS workplan** includes **six WPs** in **three main stages**:
  - Specification
  - Development
  - Assessment



- **FOCUS methodology**:
  - Rely on existing technological solutions of the participating SME's and RTD's and integration thereof (based on distinct Use Cases)
  - Enhanced with integrated sensor and RFID technology
  - Integration of other sources of freely available information (public data sets, satellite imagery, etc.)

Introduction

Motivation & Project Goals

i. **FOCUS** applicable to **any supply chain** within the **realm of the forest-based production sector**

ii. **FOCUS** aims to facilitate a **bottom-up approach**

   i. Integration of already existing solutions for different stages of a supply chain

   ii. To support optimal planning and control of the whole supply chain

iii. **FOCUS** integrates a **Model Predictive Control (MCP) approach** not present in current forest-based supply chain optimisation solutions.

iv. **FOCUS** makes use of **spatial-temporal real-time sensor data** and **map metaphor to visualize (near) real-time situation**

Literature Review

Forest-based Value Chains & Optimization thereof

- **Forest based value chains**
  - Description of adaptive ecosystem management perspective (managing under uncertainty, …) (Heinimann, 2010)
  - Overview of Wood Flow Optimization in Forestry including an overview of the Forest Supply Chain (Rönnqvist, 2003)
  - Overview of Optimization for the Log Trucks in Austria including a thorough analysis of the problem at hand (Gronalt and Hirsch, 2007)
- **Optimization of Forest based value chains**
  - Optimizing log trucks (Weintraub et al., 1996; Flisberg, Lidén and Ronnqvist, 2007; Gronalt and Hirsch, 2007; Rönnqvist, 2003; …)
  - System architectural approaches for forest supply chain management (Marques et al., 2010; Marques et al. , 2012; Scholz et al., 2008)

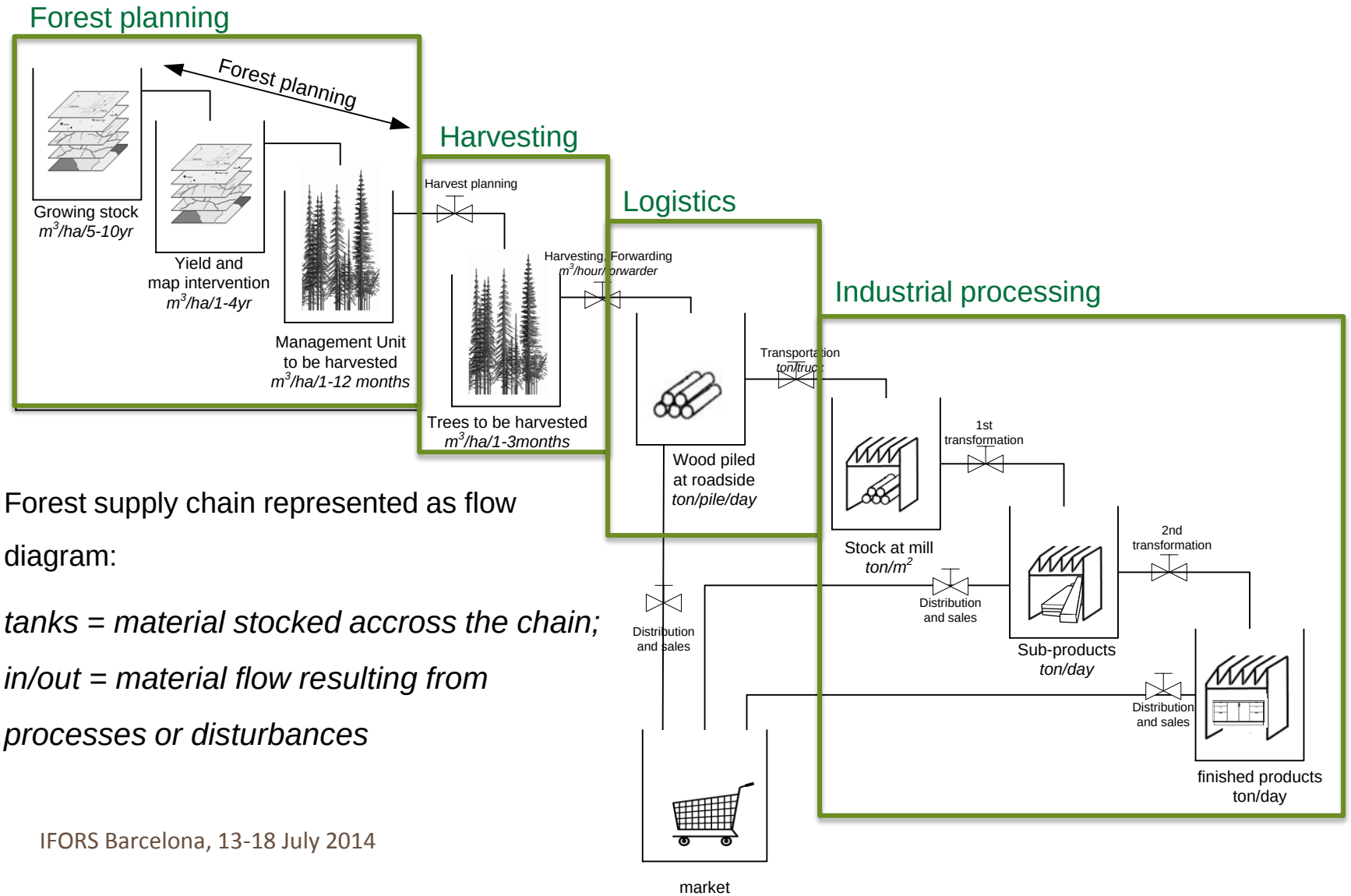
Methodology for the Design of the FOCUS Architecture

Forest-based Value Chains & Optimization thereof

- Exploratory literature review ✓
- Questionnaires and interviews to key actors in 4 pilot cases (✓)
- Systematization of the main findings into a FOCUS concept (✓)
- Workshop with IT experts on how to implement the FOCUS concept into FOCUS architecture **tbd**
- Specification of FOCUS architecture components by IT experts **tbd**

Preliminary Architecture

General Architecture and Components – Concept



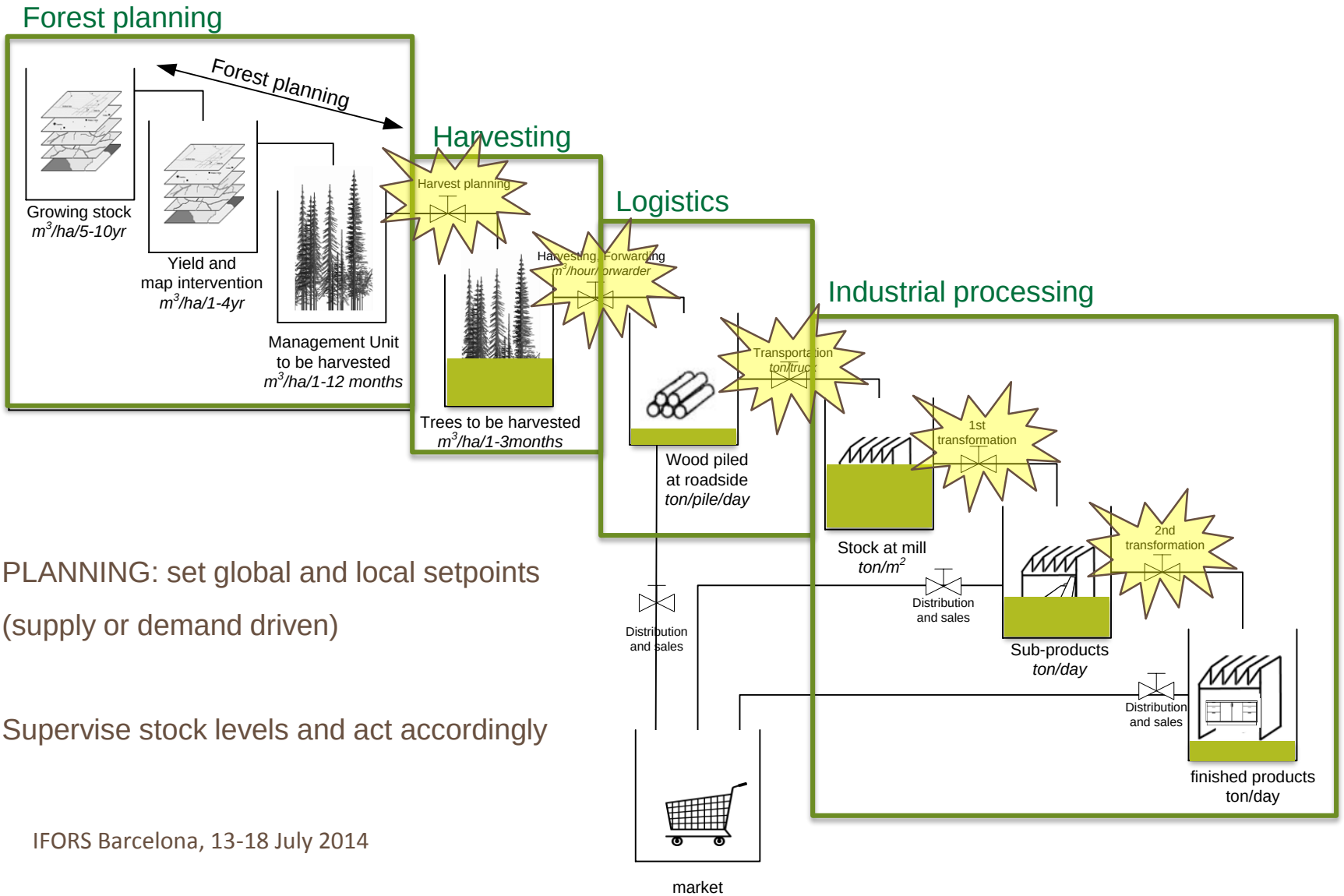
Forest supply chain represented as flow diagram:

tanks = material stocked accross the chain;

in/out = material flow resulting from processes or disturbances

Preliminary Architecture

General Architecture and Components – Concept



PLANNING: set global and local setpoints

(supply or demand driven)

Supervise stock levels and act accordingly

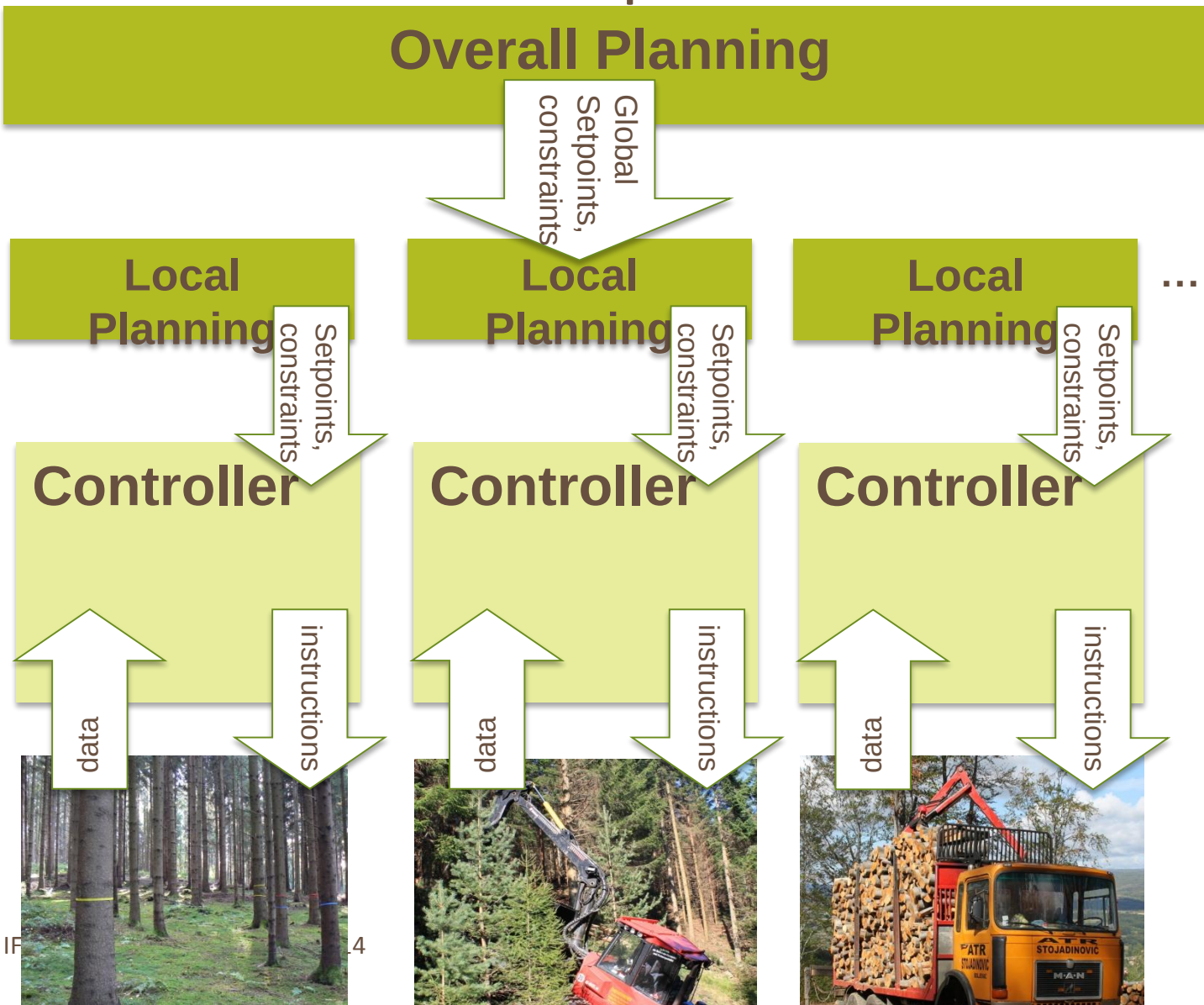
Preliminary Architecture

General Architecture and Components I

- **Core Components**
  - **Planning Component (Optimization)**
    - Sets global and local setpoints with respect to the state of the supply chain
  - **Controller:** acts locally
    - Supervise the assigned supply chain section
    - Generate control „signals“ with respect to global and local setpoints
  - **Sensors:**
    - Gather data on the supply chain
    - Enhanced by spatial & temporal dimension
  - **Service Bus:**
    - „Glue“ between the architectural components

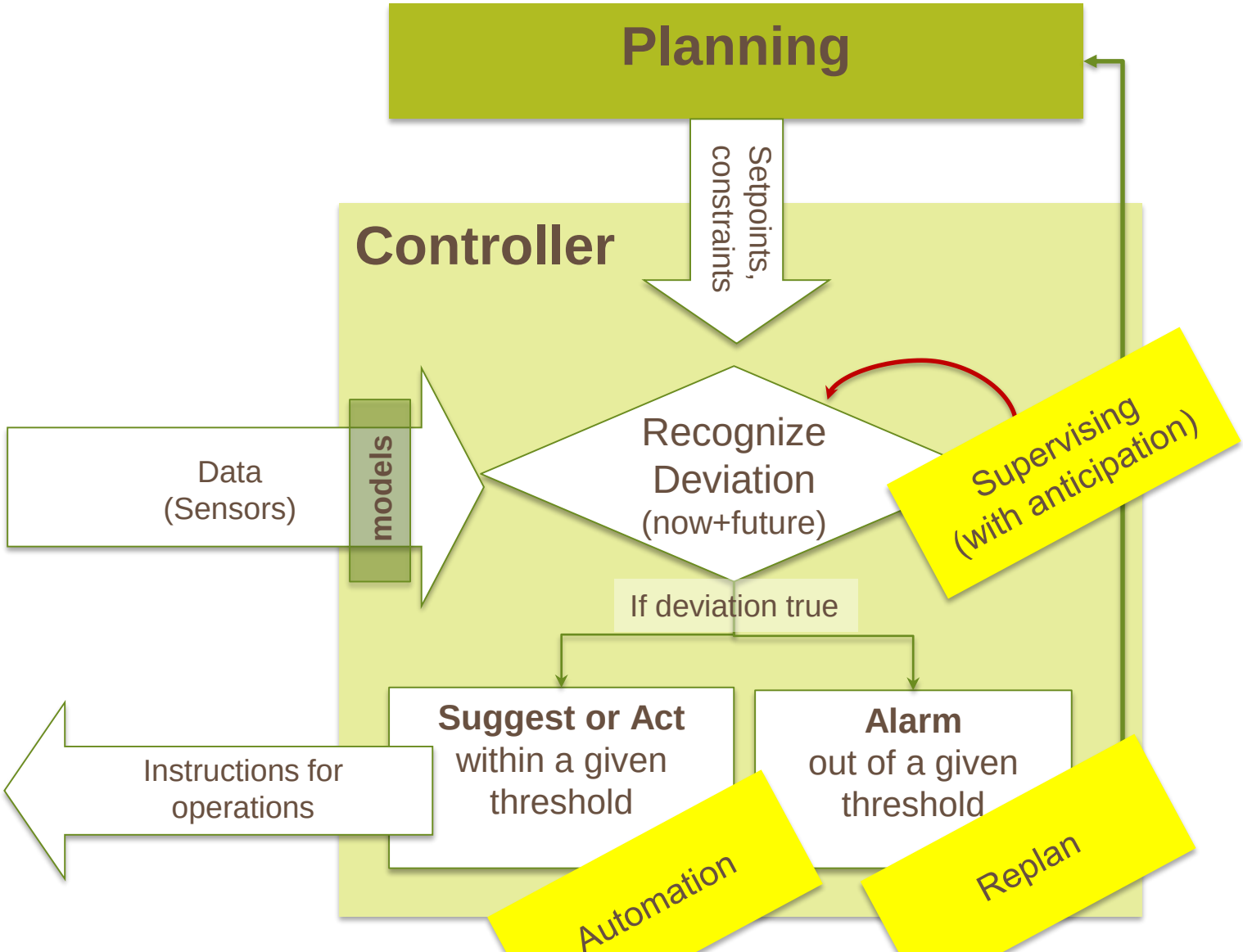
Preliminary Architecture

General Architecture and Components II



Preliminary Architecture

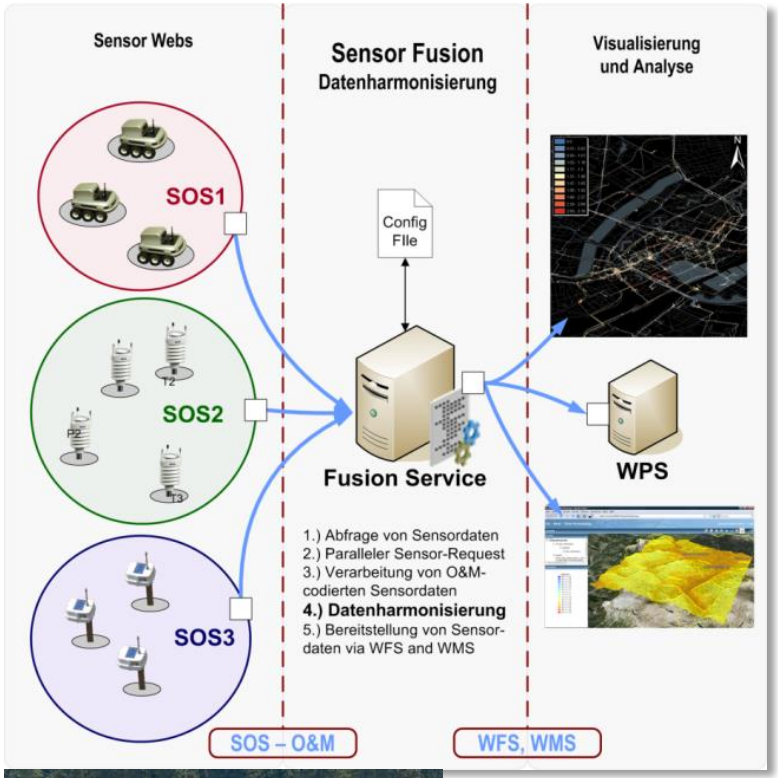
General Architecture and Components III

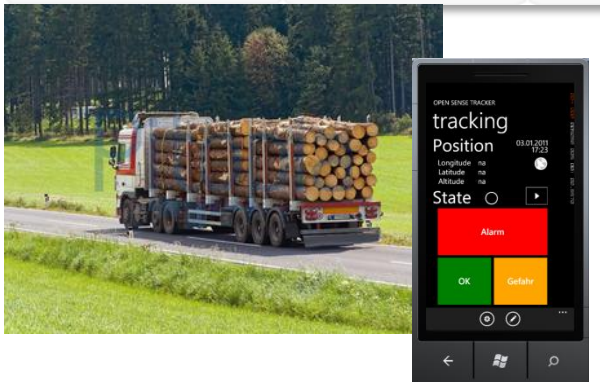


Preliminary Architecture

General Architecture and Components IV – Sensor Webs

- Data collection with the **Sensor Web** and standardized **OGC Sensor Observation Services (SOS)**:
  - Collection of (any) measurement data in a standardized way
  - Storage of sensor data in a central database that provides sensor fusion services:
    - Query sensor data
    - Parallel sensor requests
    - Data harmonization
    - Providing of data in a standardized way (Web Feature Service, Web Mapping Service)





Preliminary Architecture

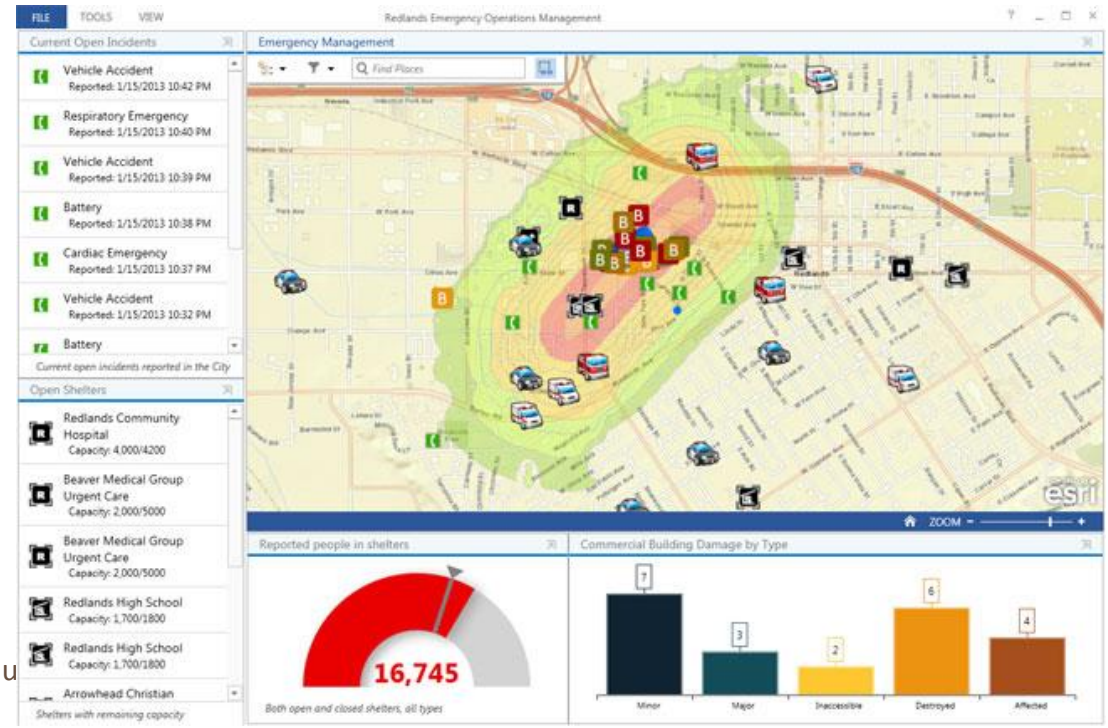
General Architecture and Components V

- **Auxiliary Components**
  - **Service Bus**
    - User Management
    - Access Control
    - Collaboration Engine
    - Service Discovery
  - **FOCUS dashboard (mobile)**
  - **FOCUS dashboard (desktop)**
  - **FOCUS data store**
    - Database engine storing data on the supply chain

Preliminary Architecture

General Architecture and Components VI - Dashboard

- **…** is "an **easy to read**, often **single page**, **real-time user interface**, showing a **(*geo*-) graphical presentation** of the **current status** and historical trends of an **organization's key performance indicators** to enable instantaneous and informed decisions to be made at a glance." (adapted from Peter McFadden, CEO of ExcelDashboardWidgets)



Example of an emergency operations dashboard. (© ESRI, 2014)

Preliminary Architecture

General Architecture and Components VI - Dashboard

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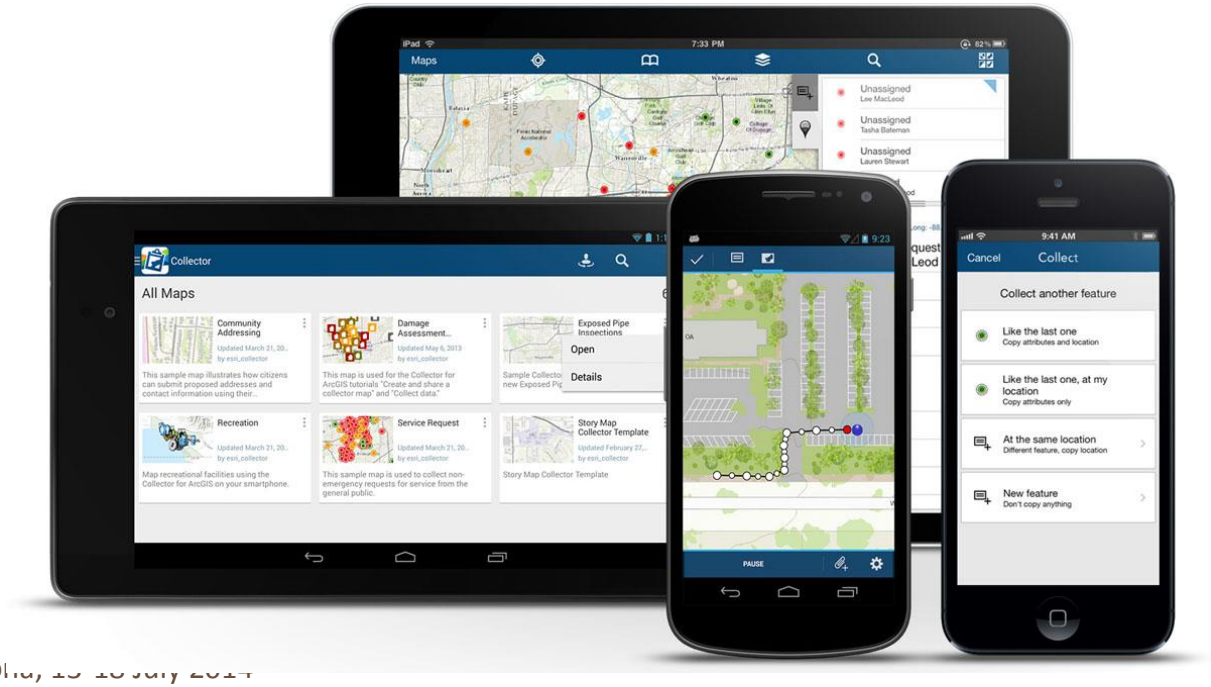
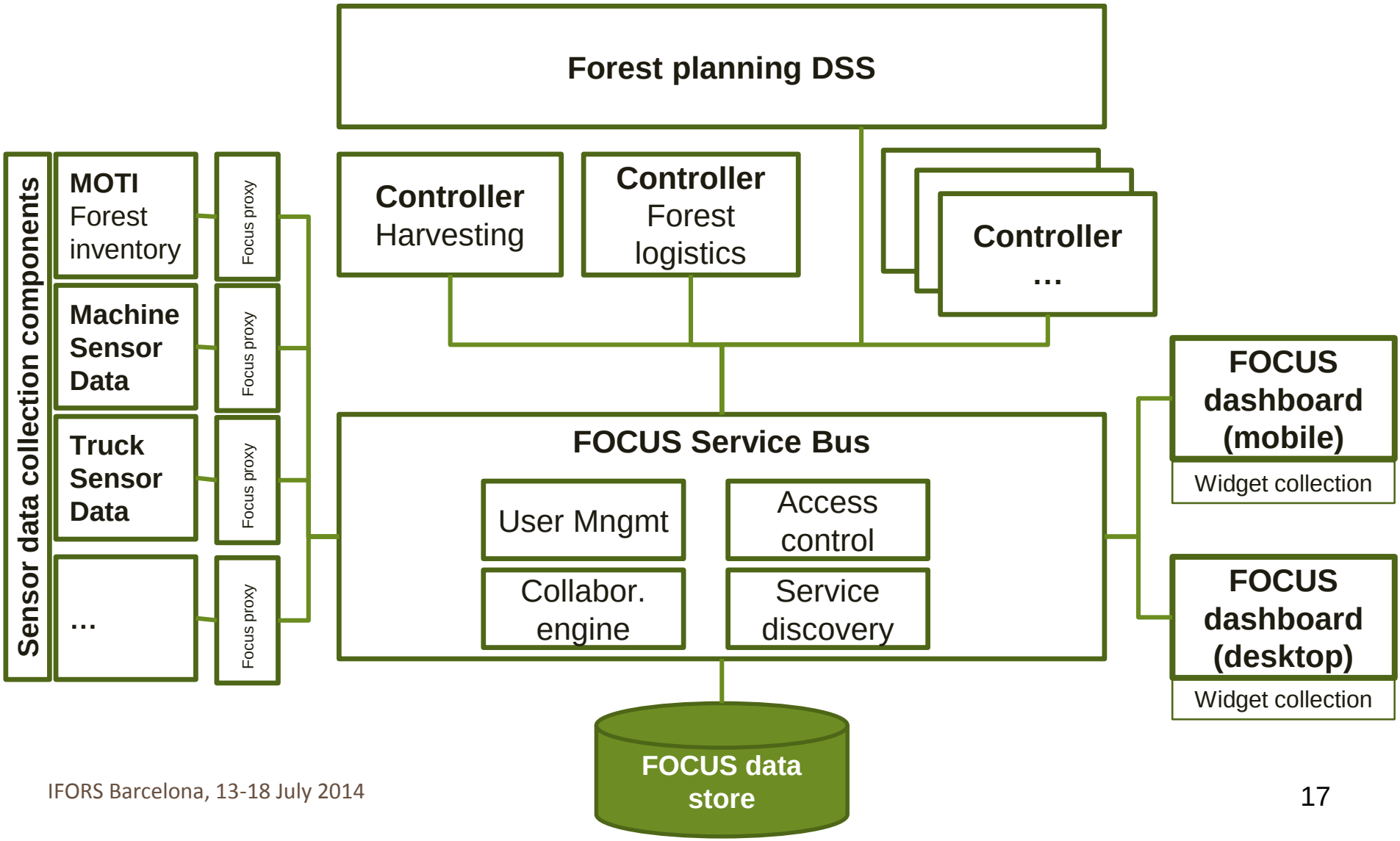


Example of mobile dashboards – **capable of delivering contextualized information.** (© ESRI, 2014)

Preliminary Architecture

General Architecture and Components VI - Overview



Preliminary Architecture

Architecture – Connection to Use Cases I

- **FOCUS Pilot Use Cases:**

- **FOCUS Use Cases can be integrated in the overall FOCUS architecture by**
  - **Plugging-in sensor data** „streams“
  - Relying on **existing** or integrate a **new controller** for the Use Case
  - Integrating **Data Storage** that represents a **model** of the **Universe of Discourse of the Use Case**
  - The **Service Bus** serves as **integration element** for the **components** (serving high-order elements on a higher abstraction level!)

Preliminary Architecture

Architecture – Connection to Use Cases II

Pulpwood, timber

Switzerland, Austria, Germany

Forest planning DSS

1. Plan

2. setpoints

2. setpoints

2. setpoints

7. Auto-mate

Controller

...

Timber piles

Machine

Sensor Data

...

Focus proxy

Focus proxy

Focus proxy

Focus proxy

Sensor data components

3. Sensor data gather-ing

4. Sensor data

8. Send instructions

6. Request & delivery sensor data

4. Sensor data

User Mngm

control

Collabor. engine

Service

FOCUS data store

Sensor Data Store (spatial&temporal)

8. Send instructions & visualize deviation

FOCUS dashboard (mobile)

Widget collection

FOCUS dashboard (desktop)

Widget collection

Conclusions and Future Work

- **Conclusions and Wrap-up**
  - **Bottom-Up approach** for Optimizing the Forest based Value Chain
  - Integration of **Model Predictive Control** appraoch to manage the Forest Value Chain
  - Integration of **spatial-temporal Sensor Data** to monitor the current status in (near) real-time
  - Making use of the **map metaphor** to visualize the current status

- **Future Work**
  - Workshop with IT experts on how to implement the FOCUS concept into FOCUS architecture
  - Specification of FOCUS architecture components by IT experts
  - Implementing Architecture and Integration of Use Cases
  - ...

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THANK YOU FOR YOUR ATTENTION!

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