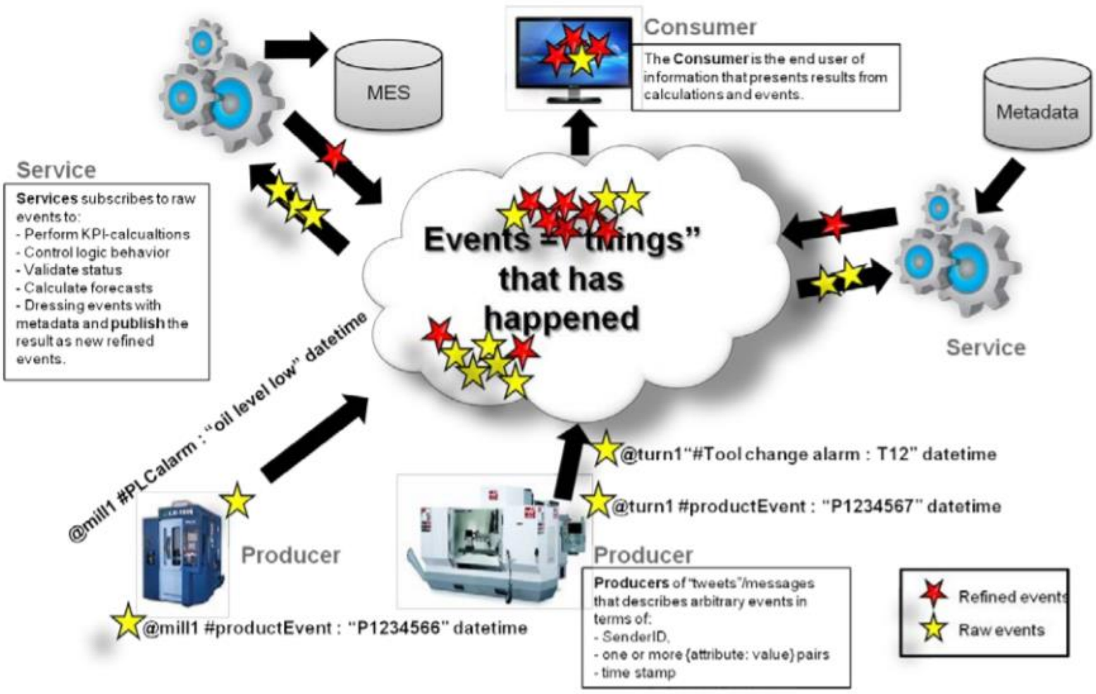
FFI Informationssystemarkitektur 2 - Smarta händelsestyrda tjänster

Publik rapport



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Projekt inom FFI

FFI Fordonsstrategisk Forskning och Innovation

Innehållsförteckning

Kort om FFI
FFI är ett samarbete mellan staten och fordonsindustrin om att gemensamt finansiera forsknings- och innovationsaktviteter med fokus på områdena Klimat & Miljö samt Trafiksäkerhet. Satsningen innebär verksamhet för ca 1 miljard kr per år varav de offentliga medlen utgör drygt 400 Mkr.

För närvarande finns fem delprogram; Energi & Miljö, Trafiksäkerhet och automatiserade fordon, Elektronik, mjukvara och kommunikation, Hållbar produktion och Effektiva och uppkopplade transportsystem. Läs mer på www.vinnova.se/ffi.

1 Sammanfattning

Projektet utvecklades en modern flexibel och skalbar händelsestyrd IT-arkitektur för insamling och behandling av data från olika automatiska produktionsutrustningar med skalbarhet ända ner till enskilda givare.

Detta ger möjlighet att söka och tolka data på olika nivåer i en fabriks ICT-infrastruktur, oberoende av begränsningar i form av fördefinierad styrlogik. För att utnyttja arkitekturen nästan gränslösa möjlighet till flexibel insamling och kommunikation av data, kommer LISA2-teamet utveckla och implementera ett antal tjänster för specifika industriella behov. Dessa tjänster kommer att omfatta:

- Analys av produktionsprestanda, övervakning, optimering och visualisering
- Enhets- och MES-kontroll
- Snabb integration och konfiguration.

I en första fas plattformen implementeras i olika lab och verkliga produktionsanläggningar. Detta gör det möjligt för fallspecifika definitioner av tjänster. De utvecklade tjänsterna måste:

- Överensstämma med industristandarder.
- Vara fristående. Gränssnitt endast mot de definierade käll- och visualiseringsåtkomstpunkter, inklusive alla nödvändiga algoritmer och historiska databaser. Detta säkerställer att tjänsterna är generella, överförbara och återanvändbara.
- Gå att kombinera. Såväl granularitet som omfattning kan utvidgas genom att aggregera enklare tjänster till komplexa.

LISA2 kommer att leverera ett antal demonstratorer för att validera de tjänster som utvecklats och därtill utvecklad kunskap.

2 Executive summary in English

The LISA-Architecture took form around 10 years ago and introduced principles like cloud based storage of information and representation of resources. It also promoted the communication paradigm shift from Push/Pull system to Publish and Subscribe logic. The last three years have seen an exponential increase of interest and consequent adoption of such technologies through modern architectures largely based on the same moving principle of the original LISA initiative. The project LISA 2 has contributed both at theoretical and practical level to the advancement of these field through the improvement and standardization of the original architecture and the development of a number of new services implemented by the industrial partners in their shop floor. Some example:

- virtual device to collect detailed data from ABB robots
- microservices transforming robot data in operation
- global positioning system for resources in the shopfloor
- analysis and visualization of operation sequences as Gantt schema
- services to optimize robot movement towards energi efficiency

The work in the project has resulted in a series of publication detailing most of the work in accordance to the NDA rules set with the industrial partners; due to time constraints, a substantial part of these publications will continue coming during 2019.

3 Bakgrund

A hidden resource in the manufacturing industry is data. Recent investigations estimate that 85% of the data and information are still unstructured, 42% of all transactions (i.e. sending and receiving information) are still based on paper. CEOs in the manufacturing industry claim “we need to do a better job capturing and understanding information rapidly in order to make sound

business decisions”. Future competitive industrial production systems need to use the data available in a much more elaborated way than they do today. Data should be transformed into information that can be used for making decisions. In addition, future sustainable competitive production systems need to be productive and flexible as well as environmentally friendly and safe for the personnel. In order to obtain this, improved control, optimization and human interaction of manufacturing processes will be needed. In addition, efficient IT system support for reduced waste of material, capital, energy and media is necessary. The common denominator is the increased need for strategic data management. A prerequisite for strategic data management is standardized generic information system architecture, which is in principle missing in the automotive industry today.
The challenge to manage data, transform it into information and make smart automated decisions has drawn a lot of attention the last years. Industry 4.0, Smart Manufacturing Leadership Coalition, Internet of Things, cyber physical systems or Industrial Ethernet are some collaborations working with the connected factory of the future. However, there is still a long way to go before these visions will become the industrial practice. Experts working with Industry 4.0, which is a strategy from the German government for the future smart factory, believe that it will be a reality in 10-20 years. The long-term aim is also to enable the smart factory, but also with an aim to use the project results already today. This project is a continuation of the LISA project, where it was shown that a modern event-driven architecture will be possible to use today as well as supporting smart services of the future.

4 Syfte, forskningsfrågor och metod

The project studied how production data was currently collected, and identified a set of common challenges. The main problem was about flexibility to handle changes. It was very hard to change what data machines and control systems did send out due to hard coded schemas. Adding or changing the physical layout of the factory also required much work due to the complicated synchronous communication methods between upper level systems and the shop floor. The solution was to introduce a modern event-based middle layer, enabling separation of concerns and lose coupling among control systems, services, machines, MES, monitoring tools, and data storage and analysis.
Event-driven and service oriented architecture: one key feature of the new approach was to simplify the data the shop-floor systems send out. By sending a simple message, an event, when e.g. a machine, a product or a sensor changes state, it will be possible on a higher level to draw conclusions about the status, as well as performance information about the system. The events are like simple tweets about status updates. These simple events are transformed by transformation services, where extra information is added and where a unified structure is created. This enables a good separation of concerns, loose coupling among systems and services and makes it much easier to change the lower level factory automation without a need to change the upper-level systems. Standards: KPIs are calculated based on a set of primitive data, like machine start and stop, production schedule, product movements, etc. However, most companies have their own definition of the KPIs as well as the primitive building blocks. LISA was therefore involved in several standardization committees in which KPIs are defined and presented. For example, the LISA project was involved in the development of both ISO 20140 and ISO 22400. Conclusion. The architecture is based on a set of powerful concepts. Still, this approach is not used in most industries. The LISA project together with the Volvo implementation has shown a great potential in using an event-driven and service oriented architecture in the automotive industry. But to really demonstrate the potential, a number of innovative services that use the full potential of the architecture are required.

5 Mål

The objective of the project is to deliver an open source event-driven information architecture, ready for industrial implementation. Together with this architecture, a range of useful services, from monitoring, alarm handling, KPI calculation to optimization and adaptive and robust distributed control will be developed and implemented in real production. The benefit of using the results from LISA2 compared to using no information architecture is estimated to:

- 50% reduction in integration time of the information system and services during changes at the plant floor,
- 30% reduction in development time when developing new services
- 90% reduction in integration time when introducing advanced prediction algorithms
- 10% energy reduction in a body-in-white due to online optimization and smart sleep model

6 Resultat och måluppfyllelse

In LISA 2 a proof-of-concept architecture, was implemented and validated with real data from Scania. Most of the ideas have been developed and implemented at Volvo Cars, in their new body-in-white line. The results were better than expected and led to development and test of a number of services including:

- virtual device to collect detailed data from ABB robots
- microservices transforming robot data in operation
- global positioning system for resources in the shopfloor
- analysis and visualization of operation sequences as Gantt schema
- services to optimize robot movement towards energi efficiency

The foillowing list includes discussion of the goals and related achievment within the project timeframe.

- 50% reduction in integration time of the information system and services during changes at the plant floor,

Eftersom LISA bygger på publish/subscribe så har det varit mycket enkelt att ändra vilka robotar vi använder och testar mot. När det gäller den nyutvecklade styrningen skulle det vara omöjligt utan LISA-arkitekturen. När vi tittar på nyare informationsarkitekturer som hamnar under begreppet industry 4.0 eller cloud, bygger de på liknande koncept som LISA.

- 30% reduction in development time when developing new services

Flera av tjänsterna hade varit mycket svåra att integrera i ett traditionellt informationssystem. Styrningen hade i princip varit omöjlig och robottjänsterna hade krävt stora förändringar. Vi har upplevt att det varit mycket smidigt att uppdatera och pussla ihop de olika delarna.

- 10% energy reduction in a body-in-white due to online optimization and smart sleep mode

I projektet har vi inte hunnit validera energibesparingen i verklig produktion, men enligt våra simuleringar verkar det gå att nå en besparing på minst 10%. Vi håller just nu på att testa detta i ITEA-projektet SPEAR. Dessa resultat är möjliga tack vara våra resultat i LISA. Sleep mode har vi inte jobbat med i detta projekt då den initiala planen begränsades då budgeten minskade.

7 Spridning och publicering

7.1 Kunskaps- och resultatspridning

Hur har/planeras projektresultatet att användas och spridas?	Markera med X	Kommentar
Öka kunskapen inom området	x	Mostly in terms of devising and implementing practices
Föras vidare till andra avancerade tekniska utvecklingsprojekt		
Föras vidare till produktutvecklingsprojekt	x	A few initiatives in the domain of digitalization have emerged within the LISA 2 community
Introduceras på marknaden		
Användas i utredningar/regelverk/ tillståndsärenden/ politiska beslut		

7.2 Publikationer

List of the most important publications. Master thesis and work only partially based on LISA 2 work have been omitted. In detail:

Theorin, A., Bengtsson, K., Provost, J., Lieder, M., Johnsson, C., Lundholm, T. and Lennartson, B. (2016) An event-driven manufacturing information system architecture for Industry 4.0. International Journal of Production Research, p. 1-15.

Zhu L, Johnsson C., Mejvik, J. Bengtsson K., Pettersson H. (2018) “Key performance indicators in Manufacturing Operations Management: A case study of the ISO-22400 standard applied at Volvo Cars, work in progress” ETFA’18, Torino, Italy, September 2018.

Zhu L., Johnsson C., Mejvik J., Varisco M., Schiraldi M. (2017): “Key Performance Indicators for manufacturing operations management in the process industry”, IEEE International Conference on Industrial Engineering and Engineering Management, Singapore, December 10-13, 2017. DOI: 10.1109/IEEM.2017.8290036

Varisco M., Deuse J., Johnsson C., Noering F., Schiraldi M.M., Wostmann R. (2018): “From production planning flows to manufacturing operation management KPIs: linking ISO 18828 & ISO 22400 standards”, accepted for INCOM 2018, Bergamo, Italy, June 11-13, 2018.

Varisco M., Johnsson C., Mejvik J., Schiraldi M.M., Zhu L. (2018): “KPIs for Manufacturing Operations Management: driving the ISO22400 standard towards practical applicability”, accepted for INCOM 2018, Bergamo, Italy, June 11-13, 2018.

Theorin A., Bengtsson K., Provost J., Lieder M., Johnsson C., Lundholm T., Lennartsson B. (2016): “An Event-Driven Manufacturing Information System Architecture for Industry 4.0”, International Journal of Production Research, Taylor and Francis, July 2016. doi: 10.1080/00207543.2016.1201604

Bauer M., Lucke M., Johnsson C., Harjunkoski I., Schlacke J. (2016): “KPIs as the interface between scheduling and control”, 11th IFAC Symposium on Dynamics and Control of Process Systems (DYCOPS’16), Trondheim, Norway, June, 2016.

Dias-Ferreira, J., Ribeiro, L., Akillioglu, H., Neves, P. & Onori, M. (2016). BIOSOARM: a bio-inspired self-organising architecture for manufacturing cyber-physical shopfloors. Journal of Intelligent Manufacturing, 1-24

Akillioglu, H., Dias-Ferreira, J. & Onori, M. (2016). Characterization of continuous precise workload control and analysis of idleness penalty. COMPUTERS & INDUSTRIAL ENGINEERING, 102, 351-358

8 Slutsatser och fortsatt forskning

Future challenges will be connected with the integration of LISA approach into IT-based services, Data-driven Product Service Systems, Service Management 4.0, Digital circular economy, Pure digital services, Digitized PSS, Smart PSS. In this sense, LISA 2 architecture needs to evolve to follows the application suggested in these domains.

9 Deltagande parter och kontaktpersoner

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