

# Ericsson Utvecklings AB

## Results from cooperation within ASTEC

### The Erlang Verification Project

Date: 22 Aug 2000  
From: Thomas Arts, thomas@cslab.ericsson.se  
Organization: Computer Science Lab, Ericsson Utvecklings AB

ASTEC experience w.r.t. the Erlang Verification Project.

During the last two years the collaboration with ASTEC (read SICS) has been based upon a jointly development of a tool for the verification of Erlang programs. The prototype of the tool had been constructed at the time of starting the project.

The first phase of the project has mainly been used by Thomas to learn to use the tool and to run a rather large case study, proving a property part of the Mnesia database. This turned out to be a challenging job, which has been reported on in an article presented at FM99.

The contribution to Mnesia has probably not been that much, but at least a patent could be written by Hans as a side-effect of the started verification.

The case study indicated that the tool lacked some features and the development of a second (totally new) version of the tool was carried out over the next year. This tool, called EVT, has been used in the Lab by a master student for performing some smaller case studies. It turned out that one still needs to learn very much in order to be able to use the tool. A user interface has been developed to partly overcome this problem.

The ASTEC partners developing the tool are very open for suggestions and try hard to make the tool as useful as possible for our needs. The development went a little slower than expected, mainly because of the underestimated amount of work that was involved in building EVT. However, without the ASTEC cooperation, we would not have had a tool at all.

The main focus now is extending and refining the tool such that a higher level of automation can be reached. This is done in parallel with some case study directly taken from the Erlang programs present within Ericsson.

ASTEC brought, above all, much knowledge into Ericsson. The area of Software Verification is a rather new one and Ericsson has to stay upto date w.r.t. the developments in this field. The ASTEC cooperation is a perfect way for that. The approach followed is state-of-the-art and leading in its field, as is demonstrated by several scientific publications.

ASTEC brought a tool to the research lab which has been and will be used on case studies of small, but realistic examples.

The cooperation also pointed out an application area for software verification, viz. software patents, which had not yet been in the picture before. Patents describe relatively small algorithms that need

to be correct, but for which it is not so important how long time the verification takes.

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## The HiPE project - letter 1

Date: 22 Aug 2000  
From: bjarne@erix.ericsson.se  
Organization: CSLab  
Subject: Evaluation HiPE

Answers from Ericsson regarding the HiPE project.

> - What did you expect from the ASTEC collaboration.

Ericsson has developed the concurrent, functional programming language Erlang and a basic system OTP (Open Telecom Platform). These are used in some large and important projects within Ericsson which finance a product unit for their maintenance and further development.

The HiPE project presents an alternative compiler based on aggressive techniques from current research. Ericsson does not use the HiPE compiler directly but benefits greatly from the collaboration with the HiPE team.

> - How are the results so far in relation to your expectations?

Much greater than expected. The HiPE team has been much more practical and concrete than we expected.

> - Did ASTEC bring any technology to your company?

The HiPE team has proposed and developed a new tagging schema for Erlang which means that Erlang programs have access to the full address space of 4 Gbyte. Their implementation has been incorporated into the Erlang/OTP compiler and this means that it can be presented to the users already in rev 7 instead of rev 8 which means several months earlier.

In addition the HiPE team has proposed many optimizations in their reports which the Ericsson development team has been able to use to improve their system.

> - Has ASTEC served as a forum for trying or assessing new technology?

Rather as discussion partner.

> - Has ASTEC contributed to your products or your development procedures?

Yes, please see above.

The manager of the Ericsson Erlang/OTP product unit hopes that this collaboration will continue at least on this level next year.

Best regards

Bjarne Däcker

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## The HiPE project - letter 2

The concurrent functional programming language Erlang was developed at Ericsson and a productified compiler and implementation is maintained by Ericsson. Erlang is available externally both open source and with support contract.

HiPE (High Performance Erlang) is a research project within Astec to develop an alternative compiler exploiting up-to-date research results.

"HiPE has been highly beneficial to us at Ericsson Utvecklings AB where we develop the Erlang/OTP product. During the six months of year 2000 we have achieved very concrete results in a short time thanks to assistance from HiPE. We have introduced a new tag schema in the Erlang virtual machine which it would have taken us many months more without the knowledge and the prototypes we received from the HiPE team.

The new solution will be included in the next version of Erlang/OTP which will be released in October. This new solution means that the Erlang virtual machine will be able to address a full 32 bit address space, i.e. 4 Gbyte (compared to 1 Gbyte with the present machine) and that it will be easier to port the implementation to other operating systems.

Furthermore we have had great use of the HiPE team with regard to compilation techniques and optimizations. In coming versions of our own Erlang compiler we expect to be able to include even further optimizations based on results from HiPE (both measurements and implementations).

We have excellent relations to the HiPE team and I really hope that their activities can continue at the same rate next year."

Rgrds, Kenneth Lundin (Manager Erlang/OTP product development)

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## IAR systems AB

### Results from cooperation within ASTEC

#### C. Industrial relevance, benefits and effects

##### Industrial involvement and interaction

From IAR Systems point of view the industrial involvement has increased since the centre started. We decided to take part in the WCET (Worst Case Execution Time) related activities in order to understand the possibilities of providing tools that could be really useful to the real-time system developer. Since then our involvement has also emerged into the related field of compiler optimisation technology, specifically the WPO (Whole Program Optimisation) technology. We have part financed several M.Sc. diploma workers as well as three industrial Ph.D. students (the Ph.D. students are working part time as researchers and part time as developers at IAR Systems AB). Until today no IAR Systems developers have joined the research related academic world (we have, however, a few developers attending higher university education on a part time basis).

##### Industrial partners' expectations

The IAR Systems expectations on the centre were very high. When joining the centre we were hoping for simple solutions to the very complex problems in the WCET area. The first try was a very pragmatic approach that was tested using a M.Sc. diploma worker. The results were very promising but did not lead to any commercial products. The reason for this was mainly the lack of interest from the IAR Systems customers (it was very hard to find the customers who really understood the benefits from the newly developed prototype tool).

Later on we have tried a more scientific approach and the amount of work put into the projects have been substantial (at least according to our measures). We have these three very skilled Ph.D. thesis workers and we really believe that we will be able to use the results that they will come up with in real commercial products within the next two years. Specifically in the WPO area we see a possibility of implementation work starting during next year. This is somewhat ironical but at the same time probably common in these research co-operations: The best results come from the projects not originally planned for but emerging in the creative environment where researchers meet the industry based developers.

##### Commercialisation and technology transfer activities

From IAR Systems perspective, no IPR-results have come out of the centre.

##### Evidence of industrial benefits

- New networks and collaborative linkages

The academic contacts have increased substantially: We now have good contacts with all the participating academic partners (SICS, KTH, UU and Mlardalens Hgskola). Our international academic contact network has also grown: From no international contacts to more or less close co-operations with German (Paderborn and Dortmund), Korean (Seoul) and American (Houston) universities. This has been one of our main benefits from the centre (so far).

The industrial partners of the centre have also contributed to our understanding of the end-user problems when using our products. My personal opinion is that we (both IAR Systems as a company and ASTEC as a centre) could improve in this area to really make full use of these valuable industrial contacts.

- Build up of new and increase of existing competence

We have not yet been able to hire any of the centre graduates (although we hope to hire all of our industrial Ph.D. students once they graduate). On the other hand we have hired quite a few graduates from the university where the first contacts have been made through the centre of the associated reserachers.

IAR Systems have also been able to offer some of our employees the possibility to attend the parts of the relevant Ph.D courses provided by the university. Thereby we have been able to give these employees both relevant education and a way of keeping in contact with the research area.

- Technical assistance and problem solving

We have been able to recruit more than five diploma workers and three Ph.D. students. These people have helped us solve a lot of interesting technical problems. We have also been fortunate enough to work together some of the more distinguished senior researchers at UU/SICS in seminars and istudy projectsi.

- Access to new ideas and know-how, evaluation of new technology

For IAR Systems the results implemented so far are only a minor part of what we believe will come:

- We have implemented (for us) the new technology of instruction scheduling,
- New and better code analysis in the compiler (to prepare for future optimisations),
- Created a better execution simulator (cycle accurate) based on a lot of the WCET experiences,
- Created a research version of our compiler in order to gather statistic information about embedded programs (this has proven to be very useful information) and,
- Used this research compiler in our internal product optimisation work.

Olle Landström  
IAR-systems AB

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## ABB Automation products AB

### Results from cooperation within ASTEC

From: ulf.h.hammar@se.abb.com  
Date: Fri, 25 Aug 2000  
Subject: Erfarenheter av AF100 projektet

Hej

Skickar en liten kommentar till projektet.

#### METODEN:

- - UPPAAL är ett mycket bra verktyg för att modellera och simulera. Det är lätt att använda och intuitivt för en programmerare. Kopplingen mellan modellen och koden är lättförstådd.

- - Redan på ett tidigt stadium hittade vi avvikelser i protokollet trots att modellen var mycket liten, framtagna på bara några timmar.

- - Vi har ännu inte fått slutrapport från Alex så vi kan inte säga hur utfallet blir.....hoppas kunna slutföra under september - oktober, så vi befinner oss fortfarande i den tidiga optimismen

- -Det står ju klart att hela modellen inte kan verifieras pga dess storlek och begränsningar i metoden men försöket att dela upp modellen i mindre modeller vilka approximerar är inte förkastligt. Att skapa flera modeller och att verifiera dem mot varandra medför förstås merarbete och risk för inkonsistens.

#### PROJEKTET:

- - Projektet har gått bra. Vi har dock från vår sida ägnat för lite tid till det. Vi satsar på "tekniköverföringen" nu i höst.

#### FORTSÄTTNINGEN:

- - Eventuella fel måste vara av en viss dignitet, dvs påverka bussens funktion, för att det ska vara försvarbart att ändra i produkten. Vi har inte funnit något sådant ännu.

- - Vi hoppas kunna introducera användningen av UPPAAL i vår organisation. Ett pilotprojekt inom nyutveckling är kanske ett naturligt sätt att börja. För att användningen ska bli bred så måste metoden ingå i processerna och projektplanerna.

- - Vi kommer troligen inte att arbeta med gammal kod. Kod som säljs och fungerar vill man inte gärna ändra.

- - Ytterligare en introduktion till UPPAAL och metoden har efterlysts och vi hoppas kunna engagera er i detta under hösten.

Mvh,

Ulf Hammar

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Gunnar Stålmärck  
Prover Technology AB

August 30, 2000

Our cooperation within ASTEC

Founded in 1989, Prover Technology is a world leader in the industrial application of Formal Methods. Prover Technology develops and applies products for automatic validation and verification to ensure that complex systems are correct, free of faults, and function according to specification. To date our methods have been successfully applied to systems developed in avionics, nuclear power generation, railways, automotive and telecommunications, as well as a number of industrial and academic research projects at national and international level.

The basis for our commercial work is our implementation of Stålmärck's method. We regard *model checking* as an important application area for our future commercial efforts. The work of the project concerns expanding the applicability of Stålmärck's algorithm to perform model checking. The initial work carried out in the project has resulted in a tool (FixIt) which scales up better than classical BDD-based techniques on several classes of systems. These early results provide strong evidence that Stålmärck's method is a most suitable basis for further development of such verification methods.

We intend to further extend our cooperation by employing an industrial PhD student during 2000/2001 to work jointly at Prover and Uppsala University.

In conclusion, the project addresses central problems with a big commercial potential for our company. We shall continue to take part in the proposed project, and expect to use the results in our future commercial activities.

Yours Sincerely

Gunnar Stålmärck

## Results of participation in ASTEC projects

This paper describes the state of the art concerning the involvement by Validation AB in ASTEC projects.

### 1. Industrial Involvement and Interaction.

Validation AB has been involved in ASTEC projects concerning Automated Testing.

During the period work has been carried out and forthcoming in areas such as testing of Web-based services dealing with objectives such as:

- The use of existing automated test tools, how to use script tools for automated test executions.
- Automated penetration of Web applications in order to apply automated test tools, graphical presentations and realisation of new test methods.

In this work Validation AB has participated in the work and supplied with test tools and equipment in our test plant.

### 2. Industrial Partner's Expectation

Validation AB is a company working with quality and test assurance.

There is a need to keep ahead with the technical and market evolution to cope with more efficient and advanced methods and tools for validation in the development process. The cooperation with ASTEC is expected to give new and extended knowledge and more efficient ways of quality assurance.

### 3. Commercialisation and Technology Transfer Activities

At present no commercialised product has been developed. The results so far are merely seen as extending the knowledge in the area and to be input for further activities in creating future products (testing and validation products).

### 4. Industrial Benefits

Benefits so far is a better understanding of needs and possibilities in the penetrated areas. An important benefit of the involvement is the transfer of knowledge between the parties

**PM**  
**Open**

SIDNR

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DATUM

25 augusti 2000

REFERENS

VDN 2200 040/2000

HANDLÄGGARE

Martin Eriksson

[martin.g.eriksson@telia.se](mailto:martin.g.eriksson@telia.se)

GODKÄND



## **Benefits and effects of participation in ASTEC**

VCT's expectations on the centre are based on the fact that the company's business is heavily relying on access to both the latest results of academic research and heavy industrial application experience. Participation in the centre helps us to further widen our contacts in the academic world, thus ensuring continued access to academic resources.

The experience from our viewpoint has been very positive this far, identifying a number of potential areas for joint activities, and research projects and completing one specific project – a diploma work. The aims of the project – to develop a packaging and scheduling algorithm for LIN (Local Interconnect Network) - has been successfully achieved. (See Appendix)

This algorithm is going to be part of a commercial product, to be launched during Q4 2000 by VCT.

We have the intension of further developing our collaboration with ASTEC in a near future due to the significant benefits we potentially can achieve.

The most important of these would be direct access to the international scientific community, increase of existing competence, and possible employment of research staff and graduates.

V. Frölunda, 2000-08-28

.....  
Antal Rajnák  
MD

### Local Interconnect Network (LIN) – Packaging and Scheduling

Magnus Ahlmark

*The usage of computer networks in vehicles is becoming more and more common. The number of computers in vehicles will increase dramatically in the next generation of new vehicle platforms. However, when adding so many computers to the car several different types of communication networks are required to reach cost effective solutions. A modern European car usually contains one or two Controller Area Network (CAN)-networks. However, when the number of computers increases so dramatically, CAN is too expensive to use for connecting simple devices such as simple switches and non-safety critical functions like indoor lights etc. Therefore, a new low cost communication solution called Local Interconnection Network (LIN) has been developed in a consortium including major car vendors, Motorola, and Volcano Communications Technologies AB. The purpose of LIN is not to replace the CAN-bus already running in the vehicles, but to be a low cost complement for connecting simple functions. In this paper, we propose a bandwidth allocation algorithm that can be applicable to the LIN protocol. The bandwidth allocation algorithm not only satisfies the performance requirements of real-time systems but also fully utilises the bandwidth of the LIN. We also present two scheduling algorithms including the process of deriving period times to satisfies the performance requirements of real-time systems*

# Volvo Teknisk Utveckling AB

## Results from cooperation within ASTEC

Date: Wed, 30 Aug 2000 13:28:44 +0200  
To: bengt@csd.uu.se  
From: Mats Larsson  
Subject: ASTEC feedback

Hej Bengt!

Ska sent omsider försöka sammanfatta vår erfarenhet från ASTEC samarbetet.

Till att börja med måste jag understryka hur litet vårt deltagande är. Vi har gjort ett exjobb hittills och avser att göra ett till. Det ger inte mycket till underlag eller påverkan på organisationen.

Det bästa tycker jag har varit ditt aktiva handledande av Johns exjobb och det stora personliga engagemang du visat. Det tycker jag är det som skiljer det här exjobbet från "vanliga" exjobb där examinatorns roll vanligtvis är ganska liten. Det gör att det känns som ett "riktigt" samarbete mellan Volvo och Uppsala universitet även om det tar sig formen av ett exjobb. En annan (antagligen besläktad) fördel jag ser är det tydliga fokus som du styrt in vårt deltagande mot. I vårt fall är det testning och då framförallt av realtidssystem. Jag tror det är bra att ha en "ram" för samarbetet annars divergerar det lätt till en mängd disparata insatser.

När det gäller nackdelar ser jag egentligen bara en och det är den geografiska tyngdpunkten hos ASTEC på Uppsala-Stockholmsområdet. Flera gånger har det varit intressanta föredrag/presentationer som annonserats av ASTEC men det är omöjligt för oss att åka till Uppsala för ett 1 timmes seminarium. Det gör att vi inte känner så stor samhörighet med ASTEC och de övriga deltagarna. Detta avspeglar sig tex. i vårt aktiva ointresse för att delta i styrelsemöten odyl. Eftersom allas tid är knapp bör man fundera över hur man samarbetar i ett distribuerat nätverk på ett tids och resurs-effektivt sätt. Utan att ha någon patentiösning inbillar jag mig att vägen framåt kan vara internetbaserad. Med detta menar jag dock mer än en hemsida. Det måste finnas en nytta med att koppla upp sig eftersom människan drivs av egenintresse. Ett förslag kunde tex. vara att sända ut alla presentationer som ges live på internet. Det skulle ge oss och andra distansmedlemmar en chans att ta del av dynamiken i ASTEC (som jag hoppas finns).

Det var vad jag kunde komma på just nu. Som sagt, ledsen att det dröjde men jag hoppas det kan vara till någon nytta ändå.

Mvh, Mats

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