The TeamPlay project:

Analysing and Optimising Time, Energy, and Security for Cyber-Physical Systems

TEAMPLAY

Time, Energy and security Analysis for
Multi/Many-core heterogeneous PLAtforms
Grant Number: 779882

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TeamPlay: Motivation

TeamPlay: Goals

- **Non-functional properties** (e.g. Energy usage, execution Time, Security) as **first class citizens**
- **Enable the developer to reason** about both the functional and the **non-functional properties** of their software at **source code level**.
- Allow **programs to reflect directly** on their own **energy consumption, time, security**, etc.,
- Effectively **manage energy consumption** for parallel systems while maintaining the **right balance with time and security**
- Develop **formally-motivated techniques** that will allow energy usage, execution time, security, etc., of parallel software to be treated effectively.

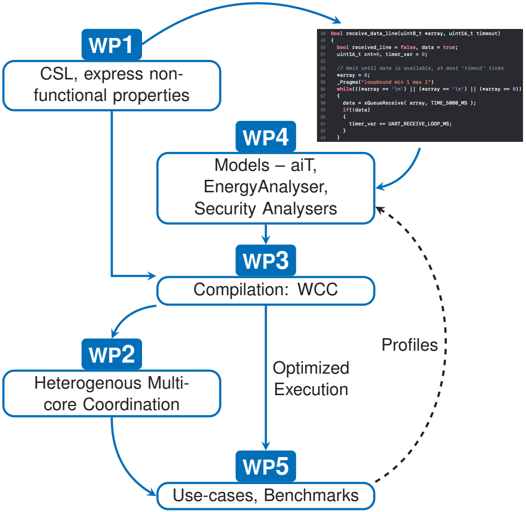
TeamPlay: 10 Partners

1. Institut National de Recherche en Informatique et Automatique (INRIA), FR
2. Thales Alenia Space Espana, SA (TAS-E), ES
3. AbsInt Angewandte Informatik GmbH (AbsInt), DE
4. Technische Universität Hamburg-Harburg (TUHH), DE
5. Systhmata Ypologistikis Orashs IRIDA Labs AE (IRIDA), GR
6. University of Bristol (UBRIS), UK
7. University of St Andrews (USTAN), UK
8. Sky-Watch A/S (SKW), DK
9. Syddansk Universitet (SDU), DK
10. Universiteit van Amsterdam (UvA), NL

Academics | Small company | Medium company | Large company

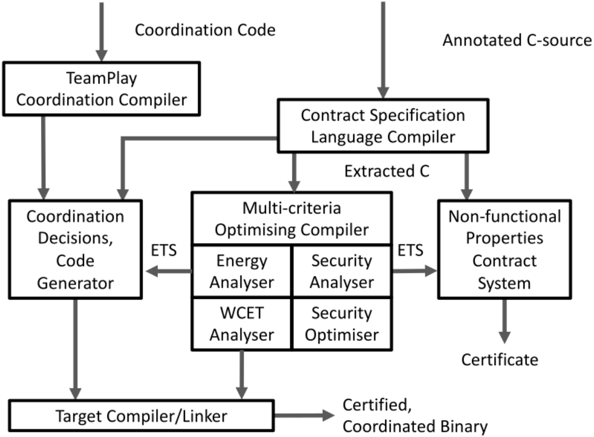
TeamPlay: Work Packages Interactions

Toolbox for developing parallel software for low-Energy systems (IoT, CPS, etc.), while maintaining the right balance with Time, Security, etc.



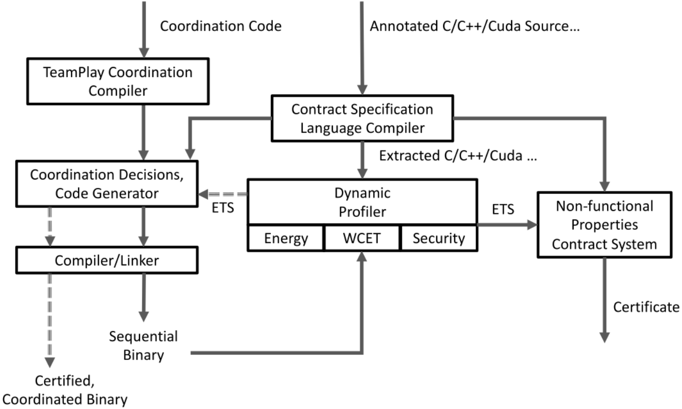
TeamPlay: "Predictable" Tool Flow

Integration of tools from different partners to build the toolbox for **predictable architectures**.



TeamPlay: "Complex" Tool Flow

Integration of tools from different partners to build the toolbox for **complex, unpredictable architectures**.



5 Use-Cases

UC1, UAV Agriculture, SDU

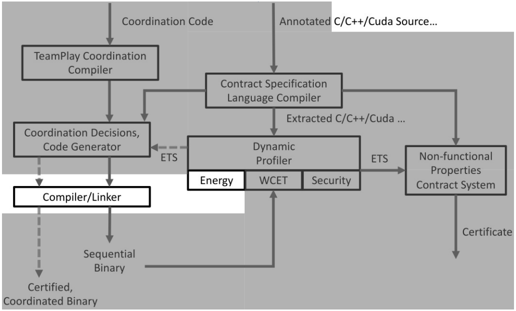
- UAV detects ground-based hazards
- Varying Quality of Service (QoS)
- Relies on popular robotics platforms
- Simulation & real environments

Challenges

- Optimize average power
- Reduce peak power
- Control time variability

Complex architecture toolflow

- Fixed-wing UAV Opterra
- Nvidia Jetson Nano
- Pixhawk flight controller
- Downward-facing camera

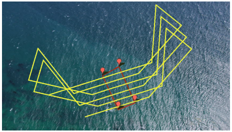


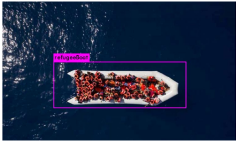
Results

- Simple power analysis
- Energy consumption profiled

UC2, UAV Search & Rescue, Sky-Watch

- UAV detects lifeboats on sea
- Energy-aware processing
- Prolong flight time, reduce heat
- Time constrained image processing





Challenges

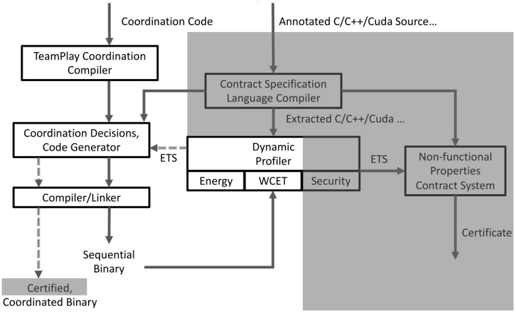
- Optimize average power
- Reduce peak power
- Control time variability
- Maintain confidentiality

Complex architecture toolflow

- Sky-Watch Cumulus UAV
- Toradex Apalis TK1
- Pixhawk flight controller
- Downward-facing camera
- In-air power measurements

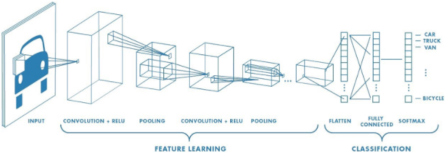
Results

- Energy consumption improvement
- Memory usage improvement
- Timing controlled
- Flight time increased



UC3, Car Parking, Irida

- Core CNN to classify car-parking lots
- Feed-Forward (vanilla) architecture
- 4D-Convolutions, MaxPool, Full-Connected
- Trained: 74000 images (32x32), with (FP) accuracy 99.69%

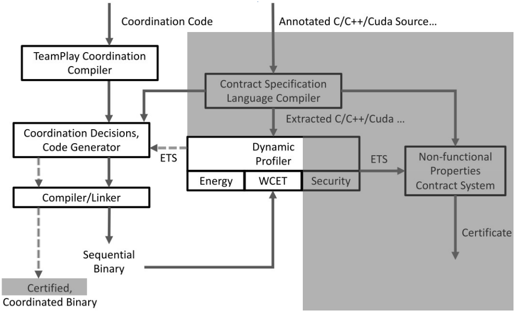


Challenges

- Optimize for embedded computing
- Decrease inference latency
- Control time variability
- Reduce average energy

Complex architecture toolflow

- Nvidia TK1
- ARM Cortex-A15
- 2GB DDR3
- 192 CUDA cores GPU

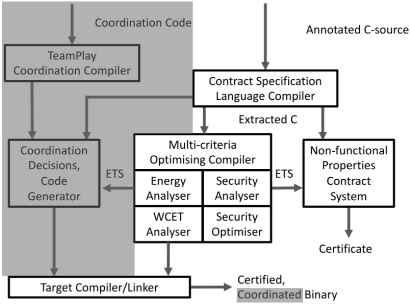


Results

- Time & energy consumption at expectations

Predictable architecture toolflow

- Nucleo Board STM32F091RC
- ARM Cortex-M0
- 32KB SRAM

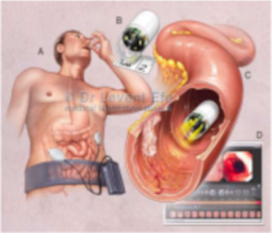


Results

- Expected latency
- Low energy consumption

UC4, Camera Pill, SDU

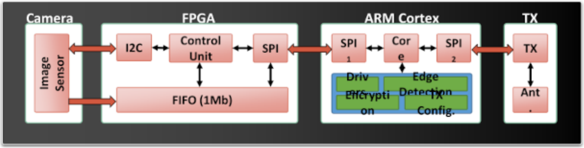
- Perform endoscopy using a pill
- On-board record images and RF transmission
- Use NN to trigger the recording



Challenges

- Very low-powered device
- Limited computing capacity
- Control time variability
- Secure wireless communications

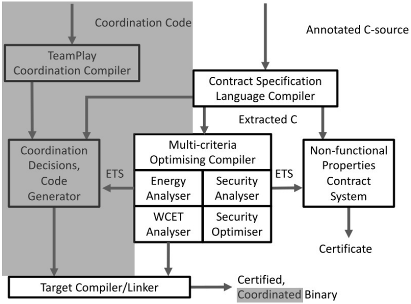
UC4, Camera Pill, SDU



Predictable architecture toolflow

Results

- Performance gain
- Lowered energy usage
- Security increased



UC5, Space Communication, Thales AE

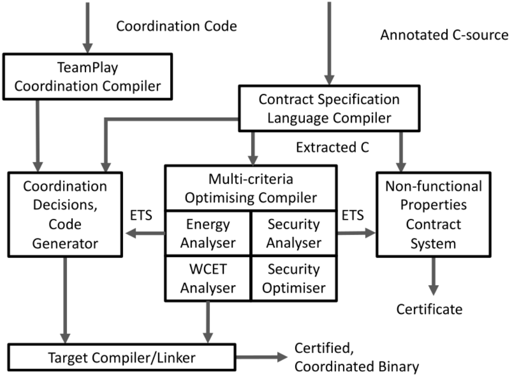
- SpaceWire links
- Satellite to satellite
- Satellite to ground station
- High rate flexible equipment for digital telecom payloads

Challenges

- Optimize average power
- Reduce peak power
- Control time variability
- Optimize worst processing time

Predictable architecture toolflow

- GR712RC eval. board
- LEON3



Results

- Fine-grained time/energy control
- Simplistic approach
- Promising results

Conclusion

Summary

- EU Horizon-2020 project: *TeamPlay*
- Jan. 2018, Jun 2021
- Goal & Achievements:
  - Time, Energy and Security methodology and toolchain
  - Support complex and predictable architectures

Openings

- Programming language support
- Extend energy modelling to other platforms
- Raise descriptions of Time, Energy, and Security to higher levels

https://teamplay-h2020.eu/

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