Building a VIP Team
A 3* semester case study of one team

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Vertically Integrated Projects Program

Georgia Institute of Technology
Intelligent Digital Communications

• Team conceptualized Summer 2013
• Research Areas (Motivations)
  – Telecommunications, primarily Internet data
  – Signal Processing
  – Radio Frequency Congestion
  – Software Defined Radio
The right graduate student

• Paul Garver, BIT-Systems employee
  – Interested in a PhD in digital signal processing
  – 4 years experience in software defined radio as a BITS employee
  – Government platform (restricted use software)

• Started Fall 2012 at GT
  – Initially tasked with some embedded systems development for the eStadium team
2013: Groundwork

- Contract with BITS in testing small hardware-platforms for SDR
  - Based on government restricted software
- Decided on GNURadio software platform for academic side
  - open source, fairly widely adopted tool in academics
- Acquired and set up GNURadio with one low-cost NI/Ettus USRP
  - FM Radio Receiver code tested as simple verification of functionality
- Developed a one page team description and committed to teaching the team beginning Spring 2014
Spring 2014 Team (GRA not included)
Spring 2014 Kick-off meeting

• 1st meeting
  – Each team member introduces themselves
    • Name, major, reason team is interesting, hobbies
• Immediate overview of team’s concept
• Initial assignment
• GT-wide orientation for new team-members
  – Grading, syllabus, facilities, expectations
Vertically Integrated Projects Program

Spring 2014: 1st Semester (1st half)

• Assignments:
  – Week 1: Install Linux on a bootable flash key
    • Contact info (email & cell) on wiki
    • Following Carefully Scripted Instructions
    • Tutorials on Linux provided
  – Week 2: Install GNURadio, run simple spectrum FFT
    • Again, mostly scripted instructions
    • Simple lecture material on signal processing concepts
  – Weeks 3,4: Implement previously proven FM Radio code
    • Verifiable results
    • Basic concepts lectures continued
  – Week 5,6: Extend software to decode Song title/artist data
    • GRA provided algorithm, students wrote code
    • (nominal results)
• Weekly meeting, GRA office hours, students worked outside of schedule times to do assignments
Key points

• Students where given clear assignments at start of semester.
  – Simple and achievable regardless of background
  – Familiar for students, assignments with clear due dates
  – Later assignments more ambiguous

• Team approach, but each student must complete each task
  – combination of collaboration and individual effort
  – Team building exercises

• Vertical Heirarchy developed:
  – Advisor => Grad => Undergrad
  – GRA graded/checked off assignments

• Assignments posted on WIKI, student's solutions also posted
  – Pushing toward self-documenting team
Spring 2014: 2nd half

- Transition from assignment-based to project-based focus
  - overlapping individual goals
- Created 3 subteams (3 students per team)
  - RBDS Decoder, Remote Monitoring, Deploy
  - Common meeting preserved
- Team dinner (should have been earlier)
- Students encouraged to link useful resources on Wiki
- Still minimal actual contributions
  - Overhead for both GRA & Advisor
First Semester Wrap Up

• Verify that work is documented in an easy way to convey to the next semester
• Encourage “tell your friends” recruiting
• Final Presentation
  – Hint: Starting point for new students next semester
Summer 2014

• Team not officially offered as a course
• Grad Student work continued
  – Built prototype RF sensor node
  – Developed key recording code
• One previous semester student hired for 100 hrs total
  – President's Undergraduate Research Award (PURA)
  – Tested existing blue-tooth decoding software, eventually recoded much of it
• Conference Publication: Comparisons of High Performance Software Radios with Size, Weight, Area and Power Constraints @ WinTech 2014
Fall 2014

- 12 Students initially enrolled, 10 completed semester
  - 4 returning students
    - 2 appointed team leaders
      - specifically tasked and discussed via office appointment
    - 6 subteams
    - One new student (sophomore, ME) promoted to subteam lead based on competence and dedication
- New students immediately tasked with an expanded version of assignments
  - Returning students manage assignments
- Clear goal of deployment and collection during football season
Fall 2014 key point

• Too many subteams
  – Culled to 3
  – Reallocated students
  – Realistic experience for students

• Students participated in 4 football game data-collection events
  – handheld test nodes + deployed hardware
  – More than a terabyte of spectrum data collected per game

• Clear effort to identify and promote suitable students to lead roles.

• Advisor is NOT central hub of all communication
Fall 2014 Grades

• Undergraduates
  – 4 A's
  – 5 B's
  – 1 C
  – 2 Withdrew by mid-term

• One graduate student participant (A)
  – Taken as a semester research special topics
  – much mentoring by advisor due to personality
Grading

• Challenge:
  – Very heterogeneous mix of students
  – Diverse work rather than N-repetitions of assignments

• Weigh:
  – Number of credits
  – Number of semesters on team
  – Sophomore, Junior, Senior

• Evaluate
  – Documentation
  – Technical Effort and Contributions
  – Teamwork
Student traits

• Newcomer
  – 1st semester, getting up to speed

• Contributor
  – Typically 2nd semester and onward

• Leader
  – Personality + Experience

• Guru
  – Technical Knowledge + Experience
Weekly meeting structure

• Different models
  – Around the table status updates
  – Rotating In-depth presentations by sub-teams
  – Working sessions
Spring 2015

• Small Team
  – Graduate Student
  – 4 returning students
  – 1 special returning student
  – 2 new students (1 withdrew)

• Very productive team
  – (Helmsley?)
Spring 2015 team
Team process – Spring 2015

• GRA seriously looking into core research questions
  – Posed theoretical/mathematical challenges

• Team Leads
  – Explored implementation to pursue challenges
    • Synchronized timing in multi-sensor environment
  – Developed test bed concept and proposed to advisor for funding

• Clear concept of solving previous semester’s challenges
  – Group effort to prioritize
Spring 2015: Team workbench
Spring 2015: Team designed testbed
Misc Spring 2015

• GRA became first-time father
• Mechanical Engineering student hired by signal processing sponsor firm to build similar boxes
  – Specific recruiting request, initial at GT
  – DoD Clearance requirements were an issue
• Team bought common t-shirts with prize money from previous semester’s innovation competition
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Questions?