CSU33D03   2023-24

Main Project

Your goal is to design, implement, validate and demonstrate an effective computer networking consensus protocol.

Consensus approaches are amongst some of the more fundamental in fault tolerant and robust computing and communications.

What must your consensus protocol achieve and demonstrate?

Your consensus protocol MUST interoperate and reach consensus with the protocol of at least one other group in the class. Up to 4 marks will be awarded for demonstrating successful interoperation and consensus with each group you successfully and effectively communicate with, up to a maximum of 12 marks for these interactions. These will be assessed in the live demo element of the interview so please ensure your group, and those that you plan to interoperate with, are fully prepared and online in advance.

Each group should implement AT LEAST 4 nodes using your specific code for demo i.e. at least 4 separate processes or instantiations (different port for each), all of which should participate in communication and consensus with every other group you communicate with.

Behaviours your consensus protocol should strive to achieve and demonstrate in demo:

i) Discover - discover other nodes on the network that you can potentially interact and collaborate with. (10 marks)

ii) Negotiate - negotiate with each of these nodes to discover their offered services, capabilities and constraints, and to advise them of your offered services, capabilities and constraints. (15 marks)

iii) Agreement - shared agreement and consensus on the collaborative activity, service or task to be provided. (15 marks)

iii) Action - an action that demonstrates the meaningful and effective use of the agreed consensus which you have just achieved. (10 marks)

Submitted codebase of original code that appropriately aligns with the demonstrated capabilities: 15 marks

Final report that concisely summarises and highlights the key group decisions and achievements: 13 marks

Intermediate checkpoints - weekly group progress. 5 x 2 marks. (Weeks 3,4,5,6,8) – to your demonstrator. 2 bullets – what aimed to achieve this week; 2 bullets – what actually achieved; 2 bullets – explain any discrepancy, and the mitigation measure to fix this; 2 bullets – any problems or issues (including groupwork).

This is a **WHOLE group FULLY ACTIVE participation** project. If either a majority of your group, or the lecturer, view you as having failed to fully contribute your score for this Project will be reduced as explained in class. Groups are included below.

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Constraints:

You CANNOT use an existing blockchain or other consensus protocol implementation in your solution.

You CAN learn from and be inspired by the ideas and concepts of others - BUT - the code you demonstrate and submit must be the work of your own group.

You CAN use standard low-level networking libraries where appropriate to provide rudimentary, low-level communication operations ONLY. All messaging, handshaking, reliability and other functionalities MUST be implemented by your group.

I will not advise on what standard low-level networking libraries are and are not permissible - it is for your group to discuss and agree on. The constraint on the use of any third party libraries is that you can utilise them to provide rudimentary, low-level communication operations ONLY. Again, it is for your group to decide what is and isn't appropriate. I will assess these decisions in interview and through the final reporting, so please keep good notes on your choices and decisions throughout.

Bonus activity: Build into your consensus mechanism i) a capability to detect malicious behaviour intended to meaningfully compromise or adversely impact the consensus approach (up to 4 marks), and ii) effective mechanisms to anticipate and mitigate such approaches (up to 4 marks).

Hardware: We can provide access to a cluster of Raspberry Pi's if you need access to machines. Please note that these machines are wholly disconnected from the TCD or SCSS networks. They run a 32bit Linux OS, and have a preinstalled suite of libraries. Additional libraries or modules will not be added or installed. You can only communicate with these Pis via the MacNeill server and an appropriate configuration of the proxy (by you) on the Pi itself. You should expect to be largely self-supporting for routine activities and tasks if using the Pis.

Example:

By way of simple example, let us assume you want to implement a basic networking protocol using sockets (low-level) that will communicate with implementations by a few other groups in the class.

i) You need to figure out what approach you are going to adopt, and ideally, who you might collaborate with;

ii) You need to agree on some mechanism by which to share, and keep updated, the 'protocol' you are going to use for raw messaging;

iii) You need to get basic messaging passing back and forward between your sender and listener (and subsequently those of the groups you plan to collaborate with). You can progress independently at this stage by putting up a few of your senders and listeners on different ports;

iv) You now need to (have figured out) or figure out what will constitute your collaboration with other group(s), what you plan to form a distributed agreement or consensus about/on, and HOW. You can't hardcode any of these elements so you need to plan for and refine them;

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v) While iv) is going on, you need to make headway on discovery of neighbouring nodes (your own or from other groups). You may decide to agree on this as part of your consensus design and discussions with other groups;

vi) Once you now what nodes are available and willing to communicate (and participate?) you can now implement your "service" or activity that requires consensus/agreement to be established and demonstrated amongst the nodes. Please keep in mind that, in the real world, things are unreliable so nodes within your consensus can (and will in demo) disappear. You need to be robust to this, detect the departure, and quickly and dynamically reestablish a new consensus to enable service/activity to continue as seamlessly as possible;

vii) In the networking example, the consensus might involve an exchange of information between nodes about the neighbours they have, and an agreement mechanism that they all participate in to determine the best route(s) for traffic to follow in each case - that they all converge/agree on;

viii) Then demonstrate your service or activity functioning with/on the consensus outcome. It is for your group to decide how best to do and achieve this.

Assessment:

Assessment will be via three submissions and one live group interview. If you fail to contribute to any of these elements, your score will be reduced/zero on that element.
   i)   Project final group report (group report – highlighting how you satisfied all requirements ; what you did, how you did it, why you did it that way, why it matters; – submit via Blackboard)
   ii)   Project final codebase (please highlight using comments the main areas of contribution of each group member to the uploaded codebase) – submit via BlackBoard
   iii)   Peer and group evaluation and self-assessment --- link to follow
   iv)   Live group interview and demo 2-4 Apr – book your GROUP slot here (only 1 booking per group):   --- Link later
   v)   Please also complete the module survey, which will be available from the Blackboard link on the last week of term. Completing the survey is valuable in helping me refine module activities for future years, and for gaining insight into anywhere the class had difficulties this year.

Groups (random assignment). Most 4 – 2 groups of 3.

Group	Username	Forename		Group	Username	Forename		Group	Username	Forename
1	KAVANAP3	PARKER		8	KHARBANA	ADITYA		15	RYANL23	LIAM
1	NIEZABIA	ADAM		8	RSAWHNEY	RAAGHAV		15	SHARMAPA	PAARTH
1	NOBLEM	MATTHEW		8	TARMSTRO	THOMAS		15	OCUILLN	NISE
1	LIUJA	JAMES		8	SODONNE6	SHANE		15	KAMBOJS	SHRESHTHA
2	HASKINSS	STEPHEN		9	SABHARWL	LAKSHAYA		16	CCASEY3	CHRISTIAN

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2	ENZOM	ENZO		9	HPANDIT	HARSHIT		16	POWEROI	OISIN
2	SSINGH8	SARA		9	HAYESOR	ORAN		16	OMALLECH	CHARLES
2	BAHADURA	ADVIK		9	DIXONBE	BEVIN		16	SWEENEE7	EIMHIN
3	CONNOM17	MICHAEL		10	BOURKECH	CHARLOTTE		17	AROCKIYA	ALBERTINA
3	TIWARIT	TANYA		10	BAGDATOV	VOLKAN		17	COPEC	CIARAN
3	RINKEA	ANNA-LENA		10	LYNCHM24	MICHAEL		17	CHAUFFOE	EVA
3	HARDIMDA	DARRAGH		10	NICOLENC	CHRISTIAN		17	MUSUMECM	MAX
4	STEINMAG	GRIFFIN		11	JURYL	LIAM		18	PATILAN	ANSHUL
4	OREILE19	EOGHAN		11	PATODID	DHAWAL		18	JOMAY	JOSEPH
4	GUPTANA	NAMAN		11	NELLIC	CLEOMENE		18	WENGJ	JUN
4	SCHILINJ	JONAS		11	MILNERG	GAVIN		18	VAISHV	VANSHITA
5	LEELE	LEO		12	CHAUDHAD	ADITYA		19	SINGLAS	SUHANI
5	QZHU	QIANJIN		12	ABHATIA	ANYA		19	WOODCOCE	ELIZABETH
5	SLAWSKID	DAMODAR		12	WALSHEAO	AOIFE		19	KOMOLAFS	STEPHEN
5	KEJOHNSO	KENNETH		12	KAYEMELN	NATHANIEL		19	GILESN	NICHOLAS
6	NIGROGAN	NIALL		13	BRADYM12	MARK		20	CARRETEA	ALEJANDRO
6	DUFFYOI	OISIN		13	NIQUIGLE	NIALL		20	IFERREIR	IGNACIO
6	RODDYD	DANIEL		13	QUINTANN	NICOLAS		20	RGARG	RITISH
6	GODBERSJ	JULE		13	WOOLAVEM	MAYA		21	HAASA	ARLENE
7	MESHCHEM	MARIA		14	CREIGHTT	THOMAS		21	DERHAMO	OLIVIA
7	MADUWUBS	SARAH		14	KONOVALD	DAVID		21	HAFISOMF	FAREEDAH
7	POWERM9	MATTHEW		14	BORANLE	LEONARDO				
7	RYANI3	ISABEL		14	QIZH	ZHI				